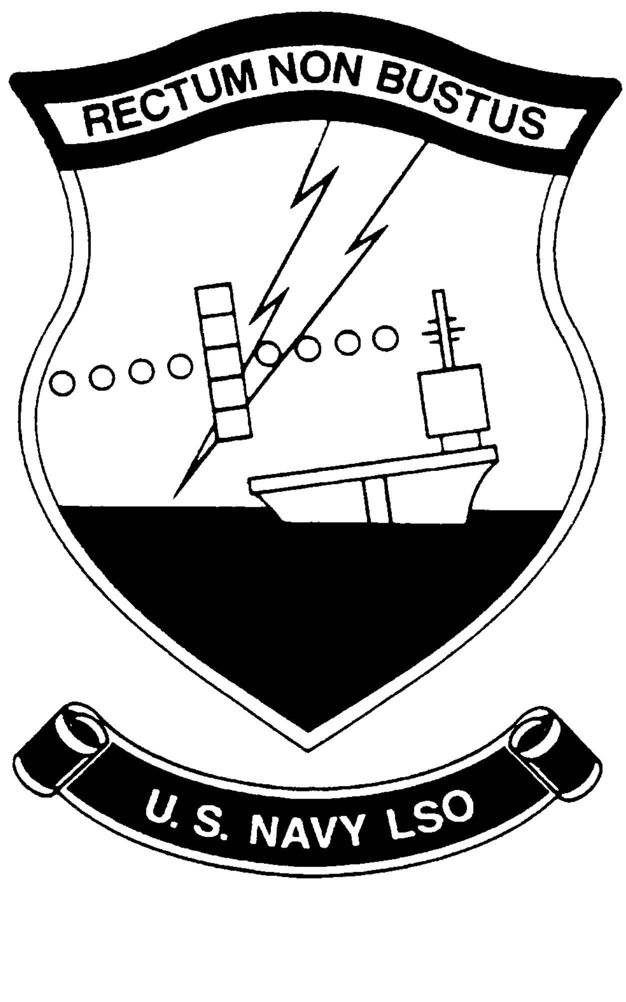
LANDING SIGNAL OFFICER REFERENCE MANUAL

(REV. B)



DEPARTMENT OF THE NAVY

LANDING SIGNAL OFFICERS SCHOOL
NAVAL AIR STATION OCEANA
VIRGINIA BEACH, VIRGINIA 23460-5129

IN REPLY REFER TO:
June 1999

In the past, most of what a Landing Signal Officer (LSO) learned was through direct experience; the longer the LSO "hung around", the more "sea stories" he had heard, the more "lessons learned" he had seen, the more he filed away for later use and as a future reference. Any technical knowledge or information he gained was usually passed by word of mouth, and only after time did the LSO become knowledgeable and proficient in his job.

Today's LSO may not gain as much experience as in the past; however, the demand on LSO proficiency is ever increasing. With pilot flight time decreasing, the procurement of replacement aircraft below requirements, and the cost of per aircraft increasing, the onus on the LSO is now greater. More than ever it is mandatory that the LSO must be able to wave a safe and expeditious recovery every time.

The LSO Reference Manual is intended to categorize and briefly explain LSO related technical references, establish a training outline for the LSO, and provide a basic document for self study. This guide is not intended to provide all the answers or to replace references which the LSO must know intimately, such as LSO NATOPS, CVNATOPS, Aircraft Recovery Bulletins, Commander Naval Air, Atlantic (AIRLANT), Commander Naval Air, Pacific, (AIRPAC), or Commander Naval Air, Training (CNATRA) instructions/SOP, etc. if used as guide, it should provide answers to many questions and point fledgling LSOs in the right direction for accurate information. As an additional caveat, the LSO Reference Manual is not intended to be used as a technical source document. Appropriate Naval Air Systems Command (NAVAIR) publications should be consulted for the most current information regarding system design, configurations, etc.

Safety is always the prime concern for the LSO. We should not have to relearn in the future what we already know today.

Requests for additional copies and/or submission of recommended changes should be directed to:

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CHAPTER 1

OPTICAL LANDING AID SYSTEMS

1.1. GENERAL

There are two optical landing systems being used by the Navy, the Fresnel Lens Optical Landing Aid System (FLOLS) and the Improved Fresnel Lens Optical Landing Aid System (IFLOLS). IFLOLS will be covered in chapter 2 of this manual.

1.2 FRESNEL LENS OPTICAL LANDING AID SYSTEM (FLOLS)

FLOLS is an electro-optical pilot landing aid. The present shipboard variant is the Mk 6 Mod 3 FLOLS, which incorporates the Carrier Landing Aid Stabilization System (CLASS). CLASS features two identical channels of stabilization complete with gyro/sensor units, electronic computers, monitoring circuits, built-in maintenance facilities, and automatic trim stabilization units. CLASS automatically corrects lens settings for static mistrim of the ship to maintain a constant preselected hook touchdown point. There are three modes of operation, inertial, point, and line. The inertial mode, which compensates for ship's heave (vertical displacement or up and down "bobbing" of the ship), is the primary mode of operations.

The FLOLS System includes a deck edge assembly (lens), the FLOLS Control Room), the Pri-Fly area, and LSO Platform. *(Figure 1-1)*

There is a vast amount of printed information available on the FLOLS. A thorough understanding of the following list of publications is a must for an LSO:

1. Technical Manual, Fresnel Lens Optical Landing System Mk 6 Mod 3, Installation, Service, Operation and Maintenance Instruction (NAVAIR 51-40ABA-10)

2. Aircraft Recovery Bulletin No. 62-12 (Mk 6 Mod 3 FLOLS)

3. Aircraft Recovery Bulletin No. 10-10.

1.2.1 Fresnel Lens Description. The Fresnel lens is a lightweight and relatively thin sheet of transparent lucite. The refraction of light rays by the Fresnel lens is collective. One surface of the Fresnel lens consists of a number of stepped facets. These facets are circular, concentric grooves that extend from the center of the lens to the edges. The slope of each facet is independent of the slope of all other facets. These slopes are designed to provide a perfect focus of the light rays which pass through the lens and causes no spherical aberration of light rays. Therefore, the light rays are not scattered. The Fresnel lens can also be formed around a suitable radius to minimize astigmatism. (Astigmatism is the inability of the lens to bring all of the light from a point on an object to a sharp focus to form the image.)

1.2.2 Lenticular Lens. The lenticular lens is the vertical fluted" lens attached in front of the Fresnel lens. It provides meatball color, azimuth ($\pm 20°$) and helps to disburse sun reflection from the lens face. *(Figure 1-2)*. The lenticular lens consists of many long, convex, cylindrical lenses placed side by side as shown in *Figure 1-3.* Each individual lens has the same short focal length. The viewing area of the object is spread by the short focal length of the lenticular lens. If the object consists of a multiple light source with spacing between the lights, the object appears, when looking into the lens as a continuous band of light which fills the width of the lens. In the Fresnel system, the arrangement of the lenses with respect to the source lamps and the physical properties of the lenses cause the source lamps to appear as a common light image 12 inches wide and of variable height depending on viewing distance. The object appears as a continuous band of light regardless of the observer's position in the azimuthal range of the lenticular lens. The azimuthal range is the angular position (expressed in degrees) in a horizontal plane in which the pilot of an approaching aircraft can observe the band of light. The azimuthal range of the lenticular lens used in the Fresnel system is 40 degrees *(Figures 1-3 and 1-4)*. The appearance of the height of the object is not affected by the lenticular lens.

The lenticular lens in each of the top four cell assemblies is colored aviation yellow during manufacture to eliminate the need for an aviation-yellow light filter, with its subsequent light attenuation. Also, sun glare from the facets of the lenticular lens is reduced. If a smooth filter were used to cover the lenticular lens, the reflection of the sun might obliterate the image. The lenticular lens in the bottom cell assembly is colored aviation-red during manufacture for the same reasons as described for the coloring of the lenticular lenses in the top four cell assemblies. In addition, the aviation red coloring of the lenticular lens in the lower cell assembly enables the pilot of an approaching aircraft to distinguish a low meatball condition at a point further aft of the touchdown point than if the lower cell assembly were colored aviation-yellow.

It can be easily "murphyed". Run your fingers across the lens face; the slots should be felt on the outside. Since it is exposed to the elements, it needs to be kept clean and dry. Salt, water, dirt, or exhaust smoke may cause spherical aberration, i.e., poor definition.

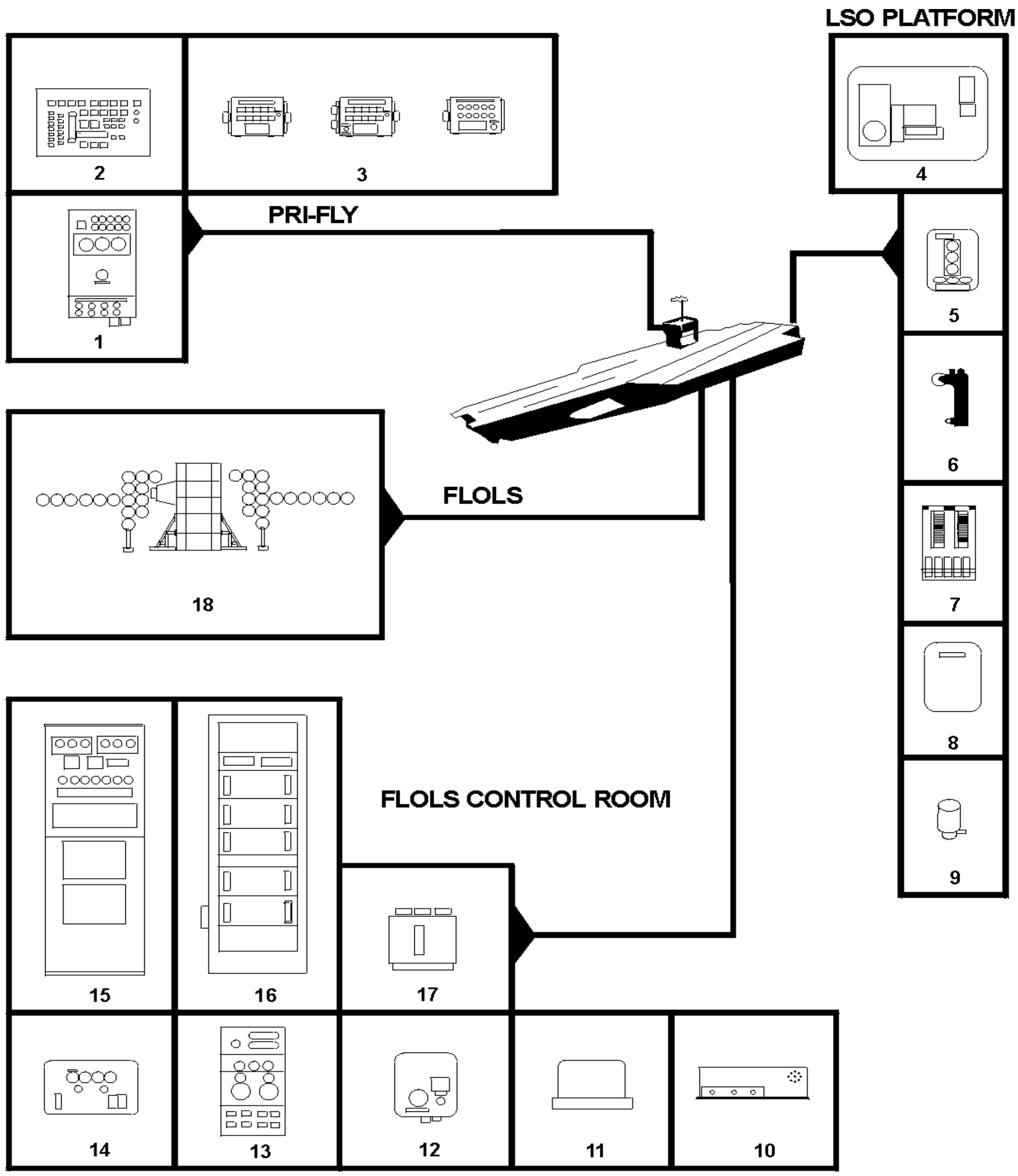
1.2.3 Optical Characteristics

1.2.3.1 Effects of Temperature. The optical characteristics of the Fresnel lens vary appreciably with changes in internal cell temperature. To maintain design characteristics of the Fresnel lens, the lens-heating compartments are maintained at a temperature which is relatively constant. The Fresnel lenses are each enclosed in a separate compartment in which the lenticular lens serves as the front and the optical glass serves as the back of the compartment. Hot air is circulated in the compartment under thermostatic control. If the lens temperature is allowed to vary beyond operational limits (100 ± 3°F), three effects will be observed:

1. As temperature varies, the size of the bar of light will appear to change as the image moves from the lens center to the transition line between cell assemblies. (The transition line is defined as the physical break between the cells.) If the temperature is higher than operational temperatures, the bar of light at the center will appear smaller and bloom to a larger bar of light at the transition line between cells. At lower temperatures, the opposite will occur.

2. The motion of the bar of light from the center of the cell to the transition line will not be smooth. At higher-than-design temperature, the bar of light appears in the adjacent cells before it starts to disappear in the observed cell. At lower-than-design temperatures, the bar of light disappears into the transition line before a bar of light starts to appear in the adjacent cell. At extreme temperatures it is possible to get blank areas or double bars of light at or near the transition point between cells.

3. The vertical field angle is larger when the ambient temperature is higher than design temperature and smaller when the ambient temperature is lower than the design temperature *(See Figure 1-5)*. In other words, the light bar is wider (i.e. less well defined ball) at higher than design temperatures and smaller at lower temperatures.



1 Lighting Remote Control Panel A710A
2 Stabilization Remote Control Panel A210/A220
3 Arresting Gear and FLOLS Cross Check Systems A600
- FLOLS Operator's P.B. Station Assembly A603
- A.G. Operator's P.B. Station Assembly A602
- Air Officer's Indicator Station A604

4 Stabilization Remote Control Panel A230A
5 Lighting Remote Control Panel A730A
6 Pickle Switch Assembly A330
7 AN/SPN42 Interface Relay Panel A340
8 Junction Box Assembly A320
9 Wave-Off Monitor A740
10 Power Supply Assembly A1700
11 Gyro Sensing Unit A2411
12 Control Box Assembly A1500
13 Light Remote Control Panel A720A
14 Disconnect and Monitor Assembly A1000
15 Power Panel Assembly A100A
16 Stabilization Control Control Console A200
17 Gyro Erection Amplifier A2401
18 Deck Edge Assembly A400

Figure 1-1 Fresnel Lens Optical Landing System (FLOLS) MK 6 Mod 3

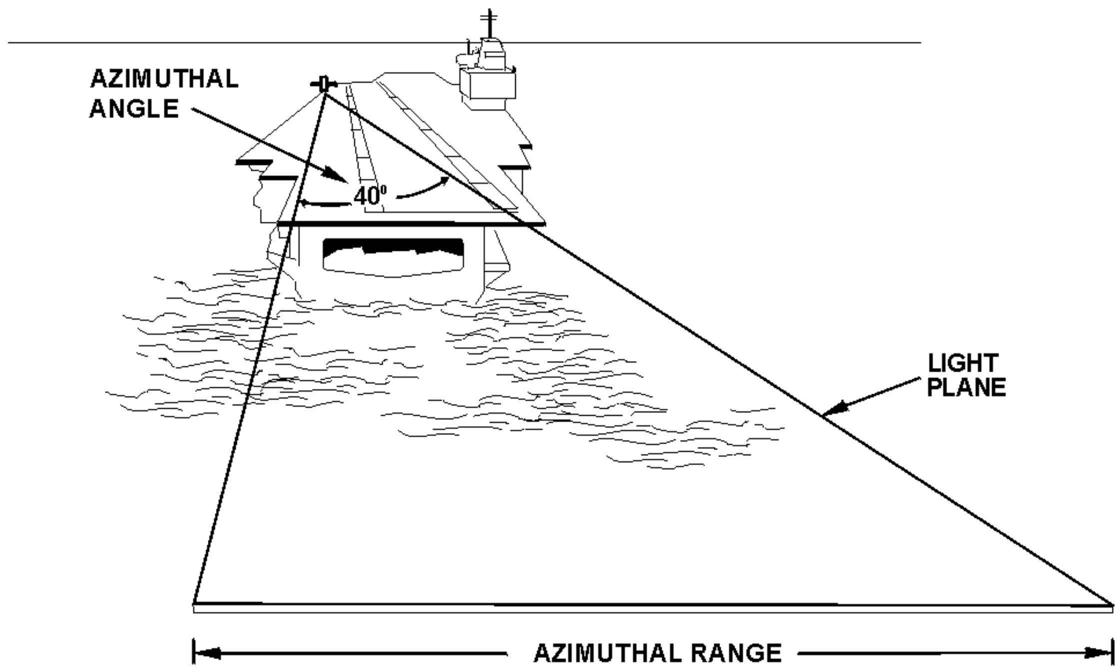


Figure 1-2 Azimuthal Coverage of FLOLS due to Lenticular Lens

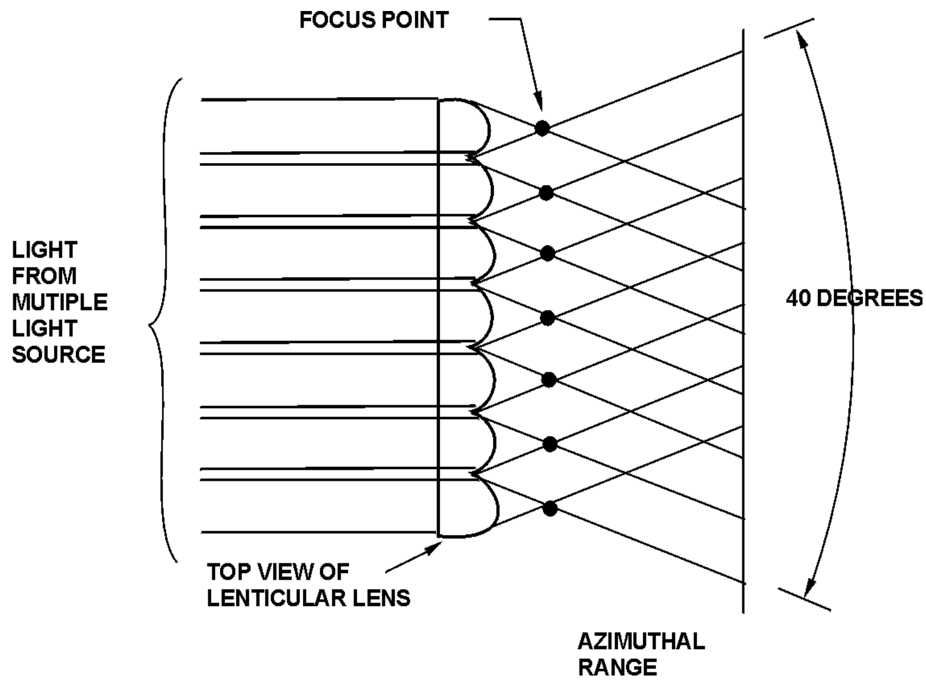


Figure 1-3 Optical Characteristics of Lenticular Lens

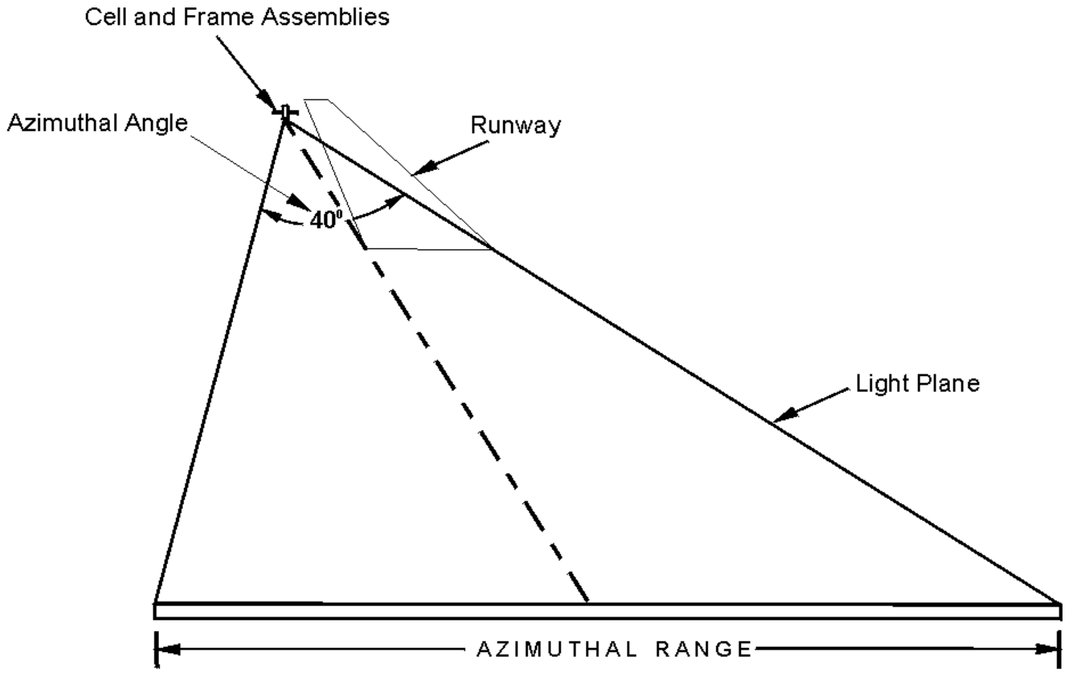


Figure 1-4 Characteristics of Light Plane

1.2.3.2 Extreme Temperatures. Extremes in cell temperature (below 90° or above 135°F) cause out of tolerance indications in Primary and the FLOLS Control Room. Over temperature may be caused by the lens heaters, outside air temperature, or aircraft spotted with exhausts pointed near the lens.

1.2.3.3 Other Optical Considerations. Since the actual lens is made of lucite, an eggcrate" backing is used to prevent Fresnel lens warp from temperature variations. If the "eggcrate" holding clamps are over tightened it will also warp the lens and cause lens transition problems. Bad transition usually cannot be detected on deck: if it can it is **really** bad. All cells are interchangeable, so the best cells should be put in the center and adjacent positions. If it is necessary to use the lens prior to complete warm-up, pilots should be informed that there may not be a smooth transition of the ball between cells and that the ball may disappear as it traverses the junction between adjacent cells. No difficulty should be experienced when the ball is in the center of the cell.

Couple the above conditions with too bright a lens setting (which significantly reduces ball definition the closer the aircraft approaches the lens), or minor visual acuity problems (pilot, weather, salt on lens, etc.), and you have unperceived glideslope deviations. Note that at 3/4 NM the center ball width is 27.1 feet. At that distance the pilot may see a centered ball without the aircraft being on the glideslope.

1.2.3.4 Focal Point and Field of View. The focal point, or virtual image of the Fresnel lens, appears 140 feet behind the lens assembly (forward in the landing area). The inherent characteristics of Fresnel optics provide the linear projected glideslope, i.e., the glideslope becomes wider or less accurate as distance from the lens is increased (linearly). The total glideslope vertical field of all five cells is approximately 1.7 degrees (each cell accounts for 20.45 minutes or .34 degrees of arc). *(Figure 1-5).*

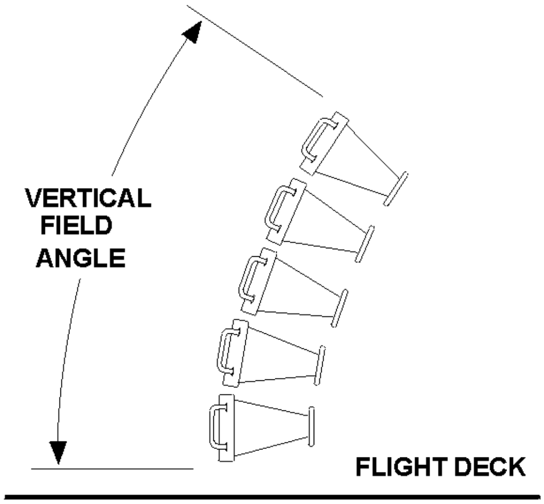


Figure 1-5 Vertical Field Angle

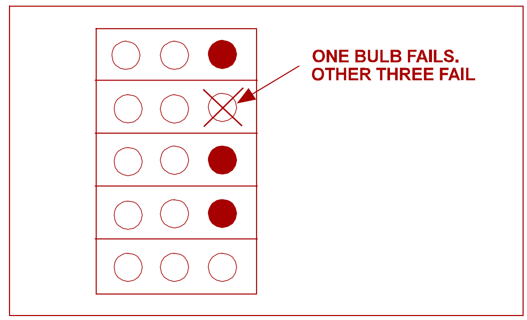
The vertical field angle of the FLOLS is best illustrated with the following table, which also shows why pilot glideslope corrections must become smaller as the aircraft approaches the touchdown point:

DISTANCE AFT OF VIRTUAL IMAGE POINT	VERTICAL BEAM HEIGHT OF ALL 5 CELLS	VERTICAL BEAM HEIGHT OF CENTER (OR ANY) CELL
375 ft	11.2 ft	2.2 ft
500 ft	14.9 ft	3.0 ft
750 ft	22.3 ft	4.5 ft
1/4 nm	45.2 ft	9.0 ft
1/2 nm	90.4 ft	18.1 ft
3/4 nm	135.6 ft	27.1 ft
1 nm	180.8 ft	36.2 ft
2 nm	361.7 ft	72.3 ft

1.2.4. Construction

1.2.4.1 Circuitry. Source lights are wired in series-parallel in the four yellow cells. Each cell contains three bulbs. If one bulb should fail, its corresponding bulb in the other three cells will go out and consequently illuminate a failure light in the FLOLS Control Room. This provides constant, even illumination:

No noticeable effect is seen with only one series burned out, but this condition will significantly speed the aging of the other bulbs. The circuitry is also designed so that all bulbs age and blacken at the same rate, thus (theoretically) producing even illumination across the cells.



1.2.4.2. General Operating Intensities. A good practice is to have lens brightness set at minimum prior to energizing the lens then adjust the intensity. This will prevent the LSO or Primary from blowing out **all** the source lights. Maximum recommended intensity settings during daylight times are near 9.0 and are usually encountered at low sun angles. Night settings normally range from 2.0 to 3.0.

Intensity in the low (red) cell is adjusted independently. It can also be flashed at a 45 cycles-per-minute rate. The flasher/steady switch is located in FLOLS Control Room on Lighting Remote Control Panel A720A.

1.2.4.3. System Conditions Indicator. System condition indicators are located on Remote Control panels A710A and A720A (in Pri-Fly and the FLOLS Control Room). The LSO platform Lighting Remote Control Panel A730A contains a GO/NO-GO indicator. *(See Chapter 4*).

1.2.4.4. Datum, Waveoff and Cut Lights. Three fixed datum lights and four conditional datum lights are mounted horizontally on each side of the lens source lights. The fixed datums are continually illuminated, while the conditional datums go out when the waveoff lights are on. Four waveoff lights and three Emergency Waveoff Lights (FLOLS service charge no. 101) are mounted vertically on each side of the lens source lights. (*Figures 1-6 and 1-7*) When a waveoff is initiated, the waveoff lights first flash at full intensity, then dim to the preset brightness. The Emergency Waveoff Lights are on a separate circuit and act as a backup system to the normal waveoff lights.

Four horizontal green cut lights are located above the source lights (2 on each side). The cut lights are illuminated by means of the push-button on top of the LSO pickle switch and by pushbuttons on all remote panels). The cut lights will remain illuminated as long as the pushbutton is depressed; once released, the cut lights go out.

1.2.5 Stabilization Modes

1.2.5.1 General. The FLOLS stabilization computer receives signals from the ships stable element in order to project a stable glideslope under moving deck conditions. Currently three modes of FLOLS stabilization are employed. They are :

1. Inertial Mode of Stabilization. Used during normal operations, this mode provides stabilization about the pitch, roll and corrects for ship's heave motion. This provides a completely stabilized glideslope from the point of visual contact with the light plane to the hook touch down point, as long as the pilot is lined up with the centerline of the angled deck. *(Figure 1-8)*

2. Line Mode of Stabilization. This mode is the primary back up mode and provides stabilization about the pitch and roll axes of the source, maintaining a predetermined line of intersection between the light plane and a true vertical plane through the centerline of the angled deck *(Figure 1-9)*. This provides a completely stabilized glideslope from the point of visual contact with the light plane to the hook touchdown point, as long as the pilot is lined up with the centerline of the angled deck. Line mode is not stabilized for ship's heave (vertical displacement). Pilot perceived ball movement from ship's motion is due to wave swell (causing heave) or motion exceeding the limits of stabilization or rate of motion compensation.

3. Point Stabilization. Used as a secondary backup mode of stabilization, the point mode provides an optical glidepath which is stabilized at a fixed point in space 2,500 feet aft of the source and in the same vertical plane with the center-line of the angled deck (*Figure 1-10*). This is the only point along the optical glidepath that is truly stabilized. The lack of a completely stabilized glideslope results in an optical glidepath which appears to the pilot of an approaching aircraft to be moving up and down with the motion of the ship, and becomes progressively more apparent (i.e. greater oscillations) as the aircraft approaches touchdown (*Figure 1-11*). Compensation for ship's motion in pitch and roll is accomplished about the lens pitch axis only.

1.2.5.2. Stabilization Limits. Lens stabilization limits are:

	Mk 6 Mod 3
point	± 6° pitch ± 10° roll
line	± 6° pitch ± 10° roll
inertial	± 6° pitch ± 10° roll ± 15 ft. heave

An additional stabilization feature limits the glideslope to a deck angle of not less than one degree. Thus, with a 4° basic angle, stabilization is limited to 3.0° stern ramp up (2.5° on a 3.5° basic angle). In a typical pitching deck situation this limitation (vice stabilization limits) usually results in apparent "lens lag".

1.2.6 Effects of Deck Motion

During flight operations deck motion seldom exceeds $\underline{+}$1.5° in pitch, +2.2° in roll, and 5.5 feet in heave. Using basic geometry, each one foot of aircraft vertical deviation at the ramp moves the hook touchdown point forward or aft in the landing area by the following distances:

Basic Angle	**Distance in Feet**
3.5°	16.4
3.75°	15.3
4.0°	14.3

Thus, 5.5 feet in heave will move the hook touchdown point $\underline{+}$90.2 feet on a 3.5° glideslope! Note also that 3° in pitch (1.5° up, 1.5° down), does not exceed stabilization limits and may not seem very significant, but 3° alone (based on CVN-71's 461 foot pitch moment arm distance) equates to 24.1 feet of total vertical ramp movement

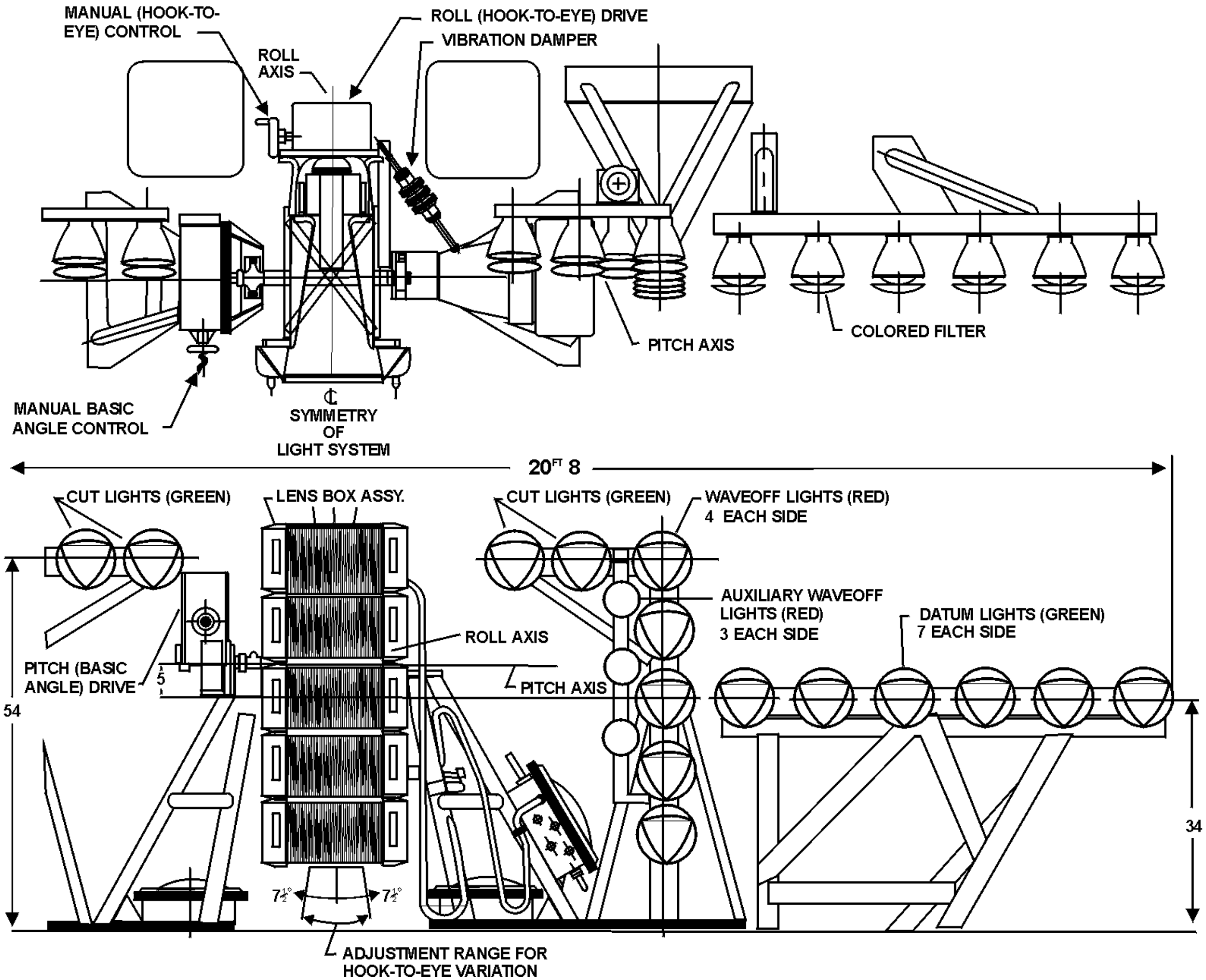
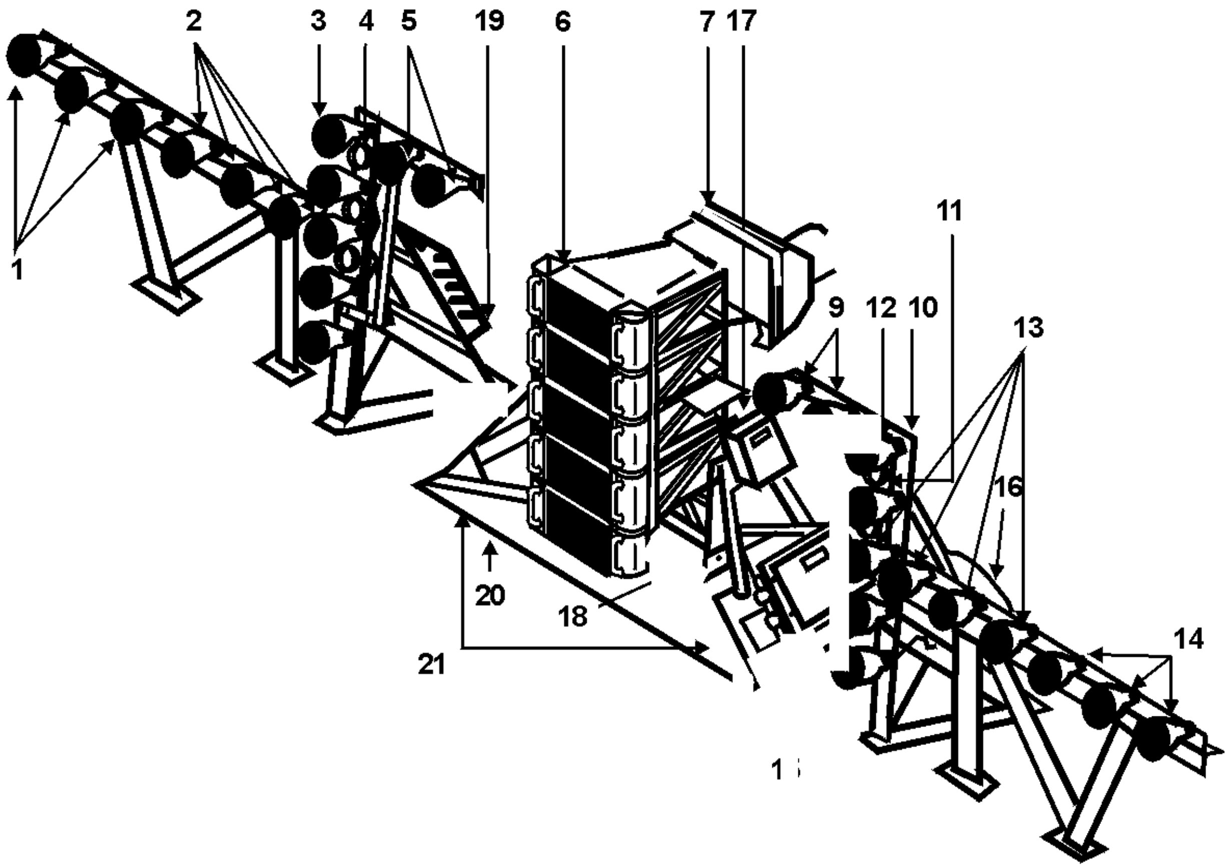


Figure 1-6 Fresnel Lens Optical Landing System - Equipment



1 Outboard Fixed Datum Lights
2 Outboard Conditional Datum Lights
3 Outboard Wave-Off Lights
4 Outboard Auxiliary Wave-Off Lights
5 Outboard Cut Lights
6 Pitch Power Drive Assembly A421 (not shown)
7 Roll Power Drive Assembly A420
8 Source Light Indicator Assembly A401
9 Inboard Cut Lights
10 Wave-Off Indicator
11 Inboard Auxiliary Wave-Off Lights
12 Inboard Wave-Off Lights
13 Inboard Conditional Datum Lights
14 Inboard Fixed Datum Lights
15 Indicator Assembly Junction Box A403
16 Inboard Main Junction Box A405
17 Auxiliary Wave-Off Junction Box A414
18 Stowlock Assembly A422
19 Outboard Main Junction Box A405
20 Baseplate Assembly
21 Baseplate Adjustment Mechanism

Figure 1-7 Deck Edge Assembly A400 (FLOLS)

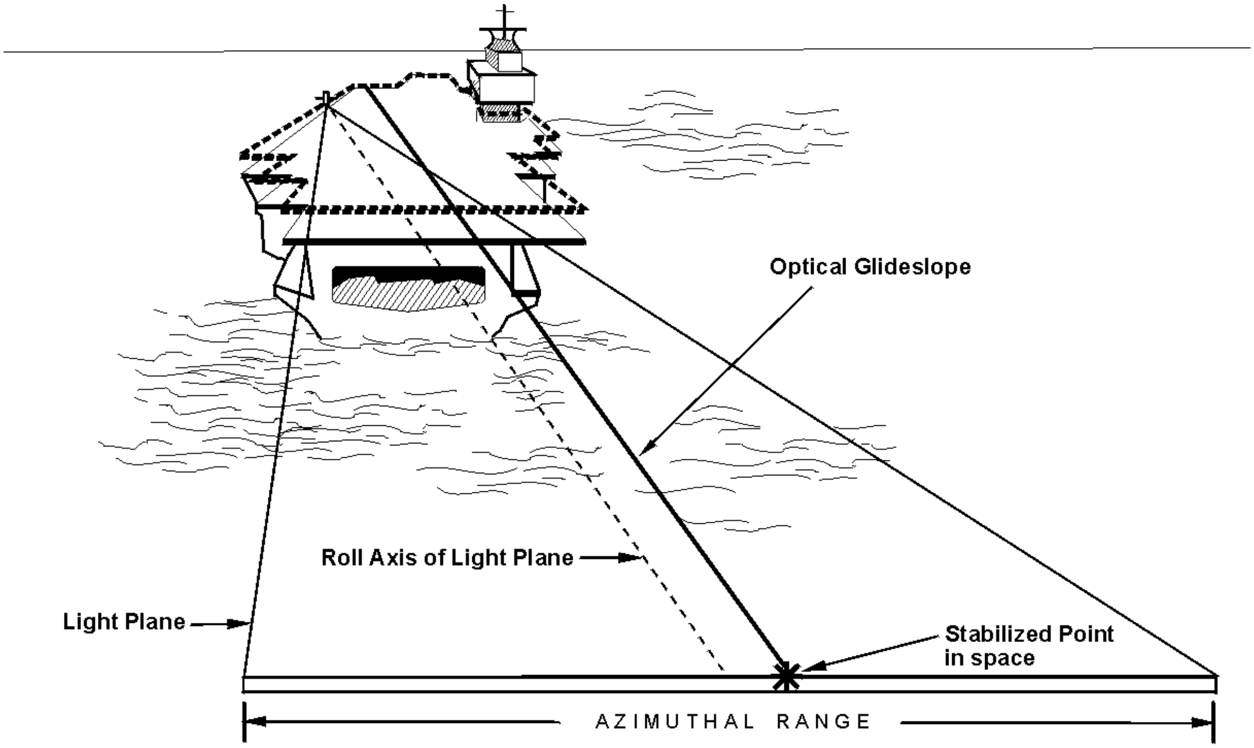


Figure 1-8 Characteristics of Inertial Mode

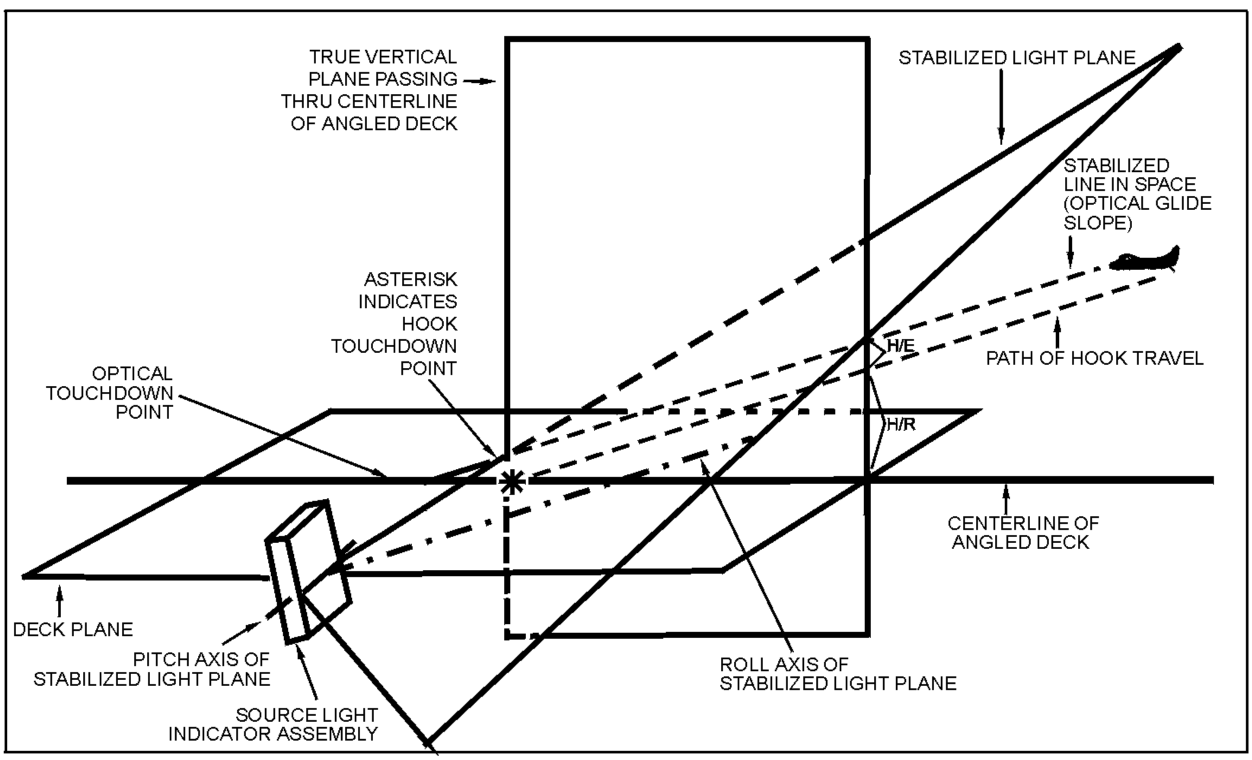


Figure 1-9 Geometry of Line Mode of Stabilization

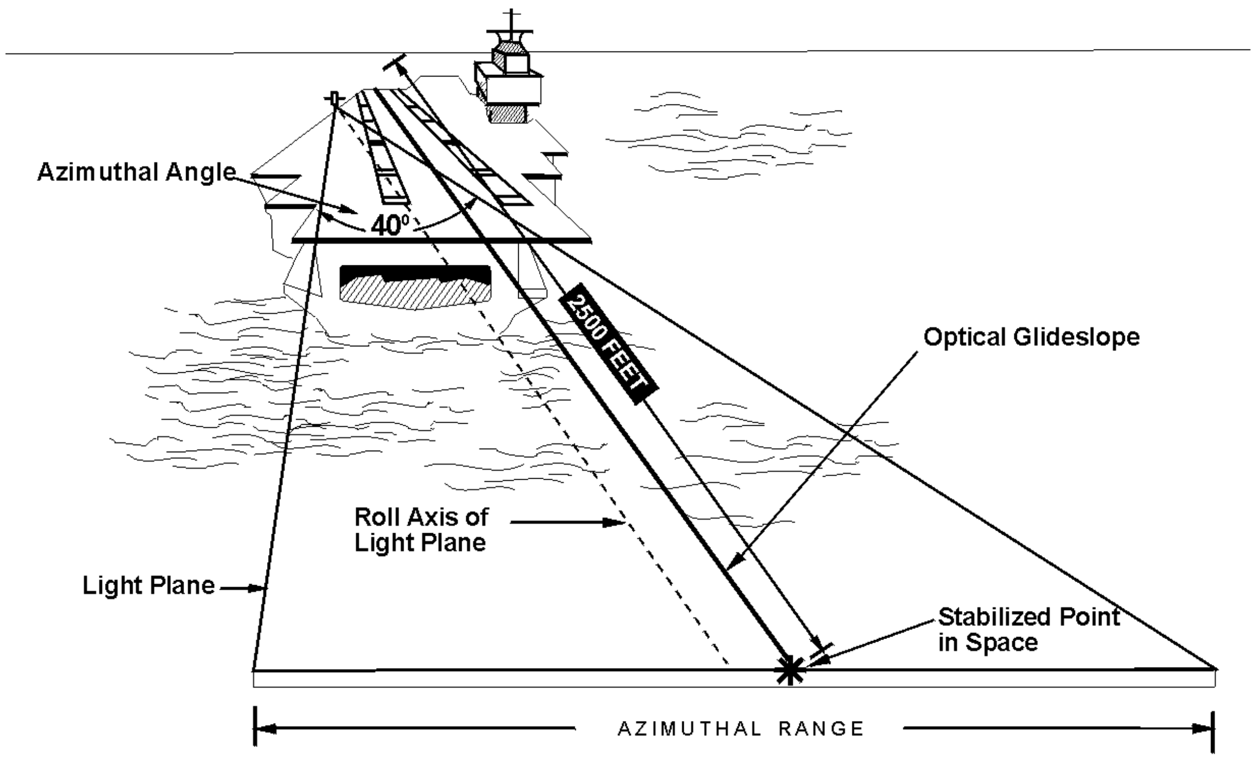
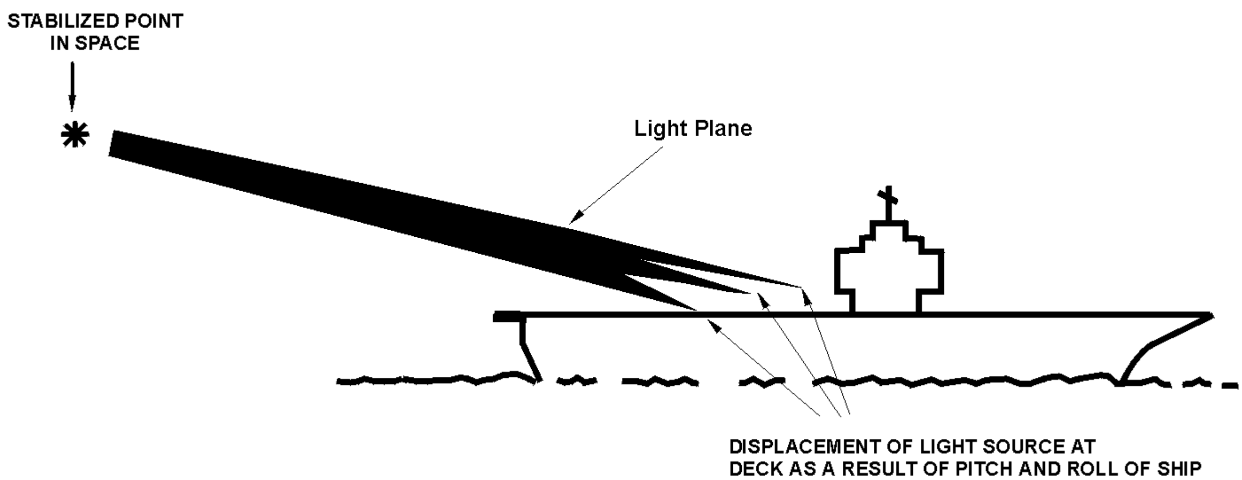


Figure 1-10 Characteristics of Point-stabilized Plane



NOTE:
Light plane displacement at deck is exaggerated for illustration purposes.

Figure 1-11 Displacement of Light Plane at Deck During Point Mode Operation

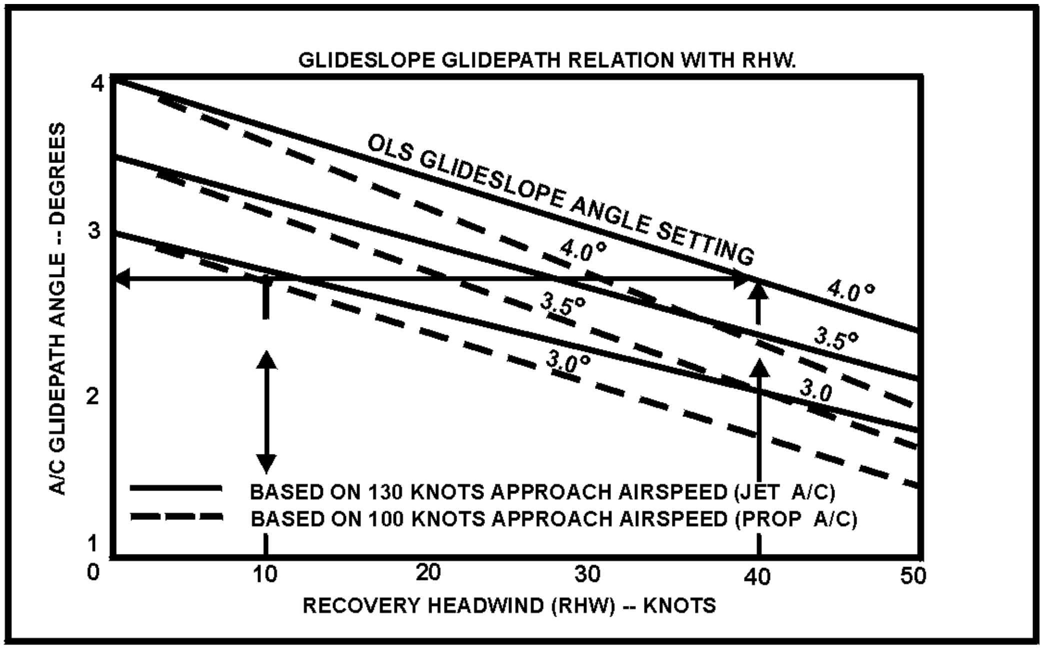


Figure 1-12 Glideslope Glidepath relation with RHW.

1.2.7 Effective Glideslope Due to Wind and Deck Motion The glideslope angle, referred to as the basic angle aboard ship, is the fixed pitch angle around which the lens assembly stabilizes. A basic angle setting of 3.5° is most commonly used, with 4° for higher wind-over-deck conditions (35+ KTS) or on the small decks where hook-to-ramp clearance is near the 10-foot minimum. In moderate wind -over-deck conditions (30-35 KTS), a 3.75° basic angle may be desirable. In *Figure 1-12*, note that decreased closure rate of aircraft to ship caused by wind over the deck reduces the actual glideslope flown to:

Wind Over Deck	Basic Angle	Effective glideslope
35 KTS	4°	3.0°
30 KTS	3.5°	2.8° (Based on a 130 KT approach speed)

This factor needs to be considered during FCLPs in order to select a reasonable compromise on glideslope angle used - considering pilot senses, aircraft power response, LSO sight picture, and aircraft aerodynamics. Remember, when selecting a basic angle for FCLP, with the relatively light winds at the field, the 2-3/4° or 3° glideslope may have the pilot and the LSO seeing a low flat glideslope. Additionally, the ball will be considerably more difficult to control as the aircraft approaches touchdown. This may be apparent in an excessive number of bolters or short landings.

Aircraft landing stress limits are predicated on moderate deck conditions. Extreme deck motion may significantly increase these landing stresses; the ramp coming up at touchdown increases relative sink rate. Additionally, 1° of ramp down is the same as adding 1° to the glideslope as far as landing stresses are concerned. These deck motion factors are among the most critical to consider when landing aircraft on carriers. During pitching deck conditions, the aircraft hook may not engage the crossdeck pendant at the optimum angle. This may result in an apparent increase in the frequency of hook-skip bolters.

1.2.8 Roll Angle Vs. Hook-to-eye The lens assembly can be tilted about two horizontal planes (at right angles to each other) which approximate the ship's pitch and roll axes. The tilt in pitch gives the basic angle and is seldom changed (3.5° or 4.0°). (*Figure 1-13*). Moving the lens about the roll axis rolls the glideslope and causes the glideslope at the centerline of the landing area to be raised or lowered.

(*Figures 1-14 and 1-15*). This compensates for the various hook-to-eye (H/E) distances to provide a constant **hook** glidepath for all aircraft. Hook-to-eye, which varies among aircraft, is the vertical distance between the hook path and the pilot's eye path with respect to the glideslope. Aircraft Recovery Bulletin No. 62-12 provides hook-to-eye values for all aircraft and configurations. These H/E values, along with basic angle, desired hook touchdown point, and ship's static pitch/roll mistrim, are used by the CLASS system to calculate the proper lens roll angle. Roll angle varies from 0 to 15 units. At 7.5 units roll angle, the lens is vertical (zero tilt); 15 units cants the top of the lens 7.5 degrees outboard and provides the maximum ramp clearance for the largest hook-to-eye aircraft. The selected basic angle will not change when the lens roll angle is increased or decreased.

See *Figure 1-16* for a depiction of aircraft hook-to-eye distances and the optical glideslope.

CAUTION

> Due to roll angle, extreme off center approaches for aircraft with large H/E values may provide hazardous ramp clearance.

Hook-to-eye values for most aircraft are such that the lens is upright or tilted top outboard (a positive roll angle, greater than 7.5 units).

No roll or basic angle settings are used for MOVLAS as the LSO manually controls the ball to establish the proper glideslope. Most field optical landing systems use basic angles only and each aircraft will have a different touchdown point based on its H/E value.

All published lens settings are intended to provide optimum hook glidepath, with a hook touchdown point halfway between the number two and number three cross-deck pendants. Roll angle places the visual glideslope some distance above the hook glideslope which corresponds to each aircraft's hook-to-eye. Hook-to-eye (in feet) is determined for each aircraft while properly configured, flying on speed attitude, and with a centered ball. This means that it is possible to have a centered ball at touchdown, but, if off optimum attitude, pick up a wire other than the targeted number three. On some aircraft (EA-6B, E-2, etc.), a change in configuration will significantly change hook-to-eye and is specified as such in the Aircraft Recovery Bulletins.

What if you don't want the hook to touchdown halfway between the two and three wires, such as if the three or four wire is missing? Since hook touchdown point is one of the inputs to the CLASS system, any desired hook touchdown point may be selected. The only restriction is to ensure that the new hook touchdown point is far enough forward in the landing area to guarantee at least 10 feet of static hook-to-ramp (8 feet for a barricade engagement).

Deck centerline camber (i.e. the centerline is higher than the deck edge) provides for water drainage. Deck camber is about 4" on most decks. All lens settings Aircraft Recovery in the Bulletins compensate for deck camber.

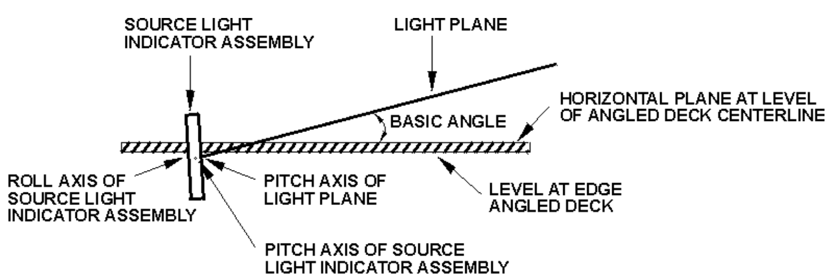
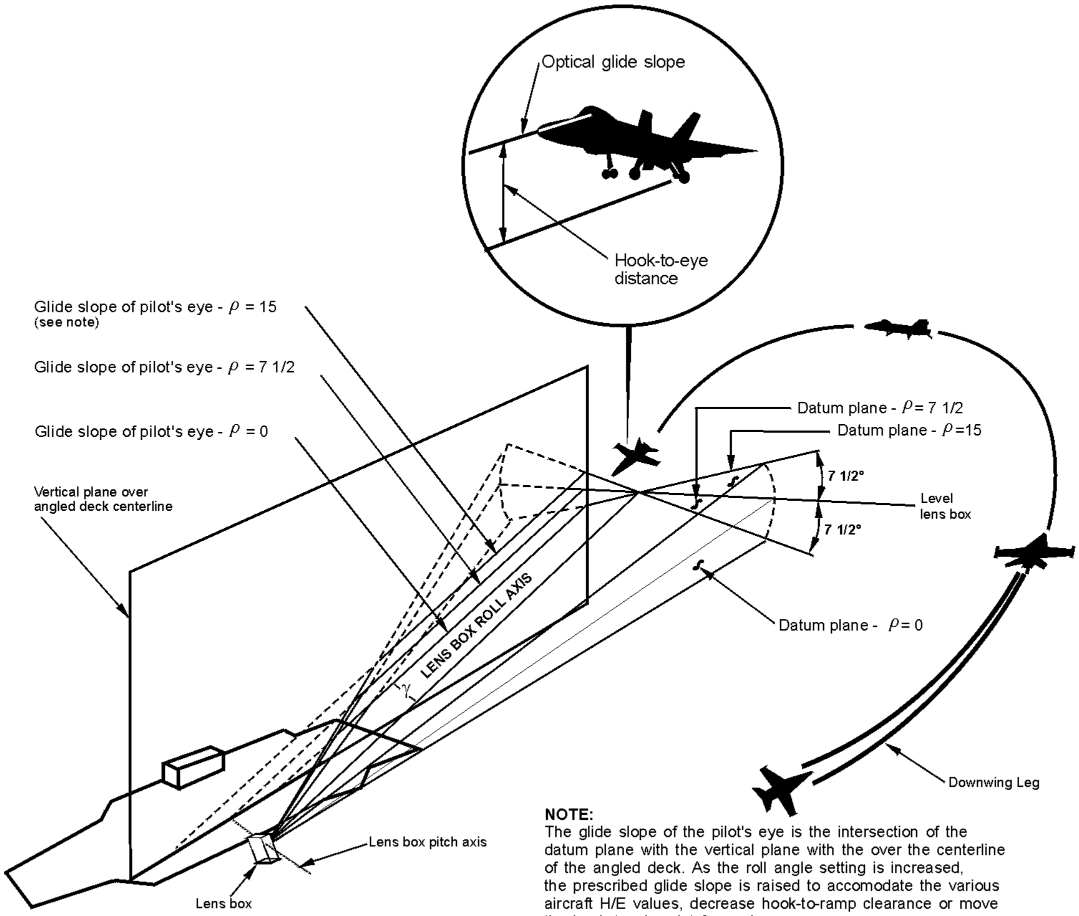


Figure 1-13 Determination of Basic Angle



NOTE:
The glide slope of the pilot's eye is the intersection of the datum plane with the vertical plane with the over the centerline of the angled deck. As the roll angle setting is increased, the prescribed glide slope is raised to accomodate the various aircraft H/E values, decrease hook-to-ramp clearance or move the hook touch point forward.

LEGEND
ρ = Roll angle modicator setting (units)
γ = Basic angle setting (degrees)

Figure 1-14 Fresnel Lens Optical Landing System – Operating Schematic

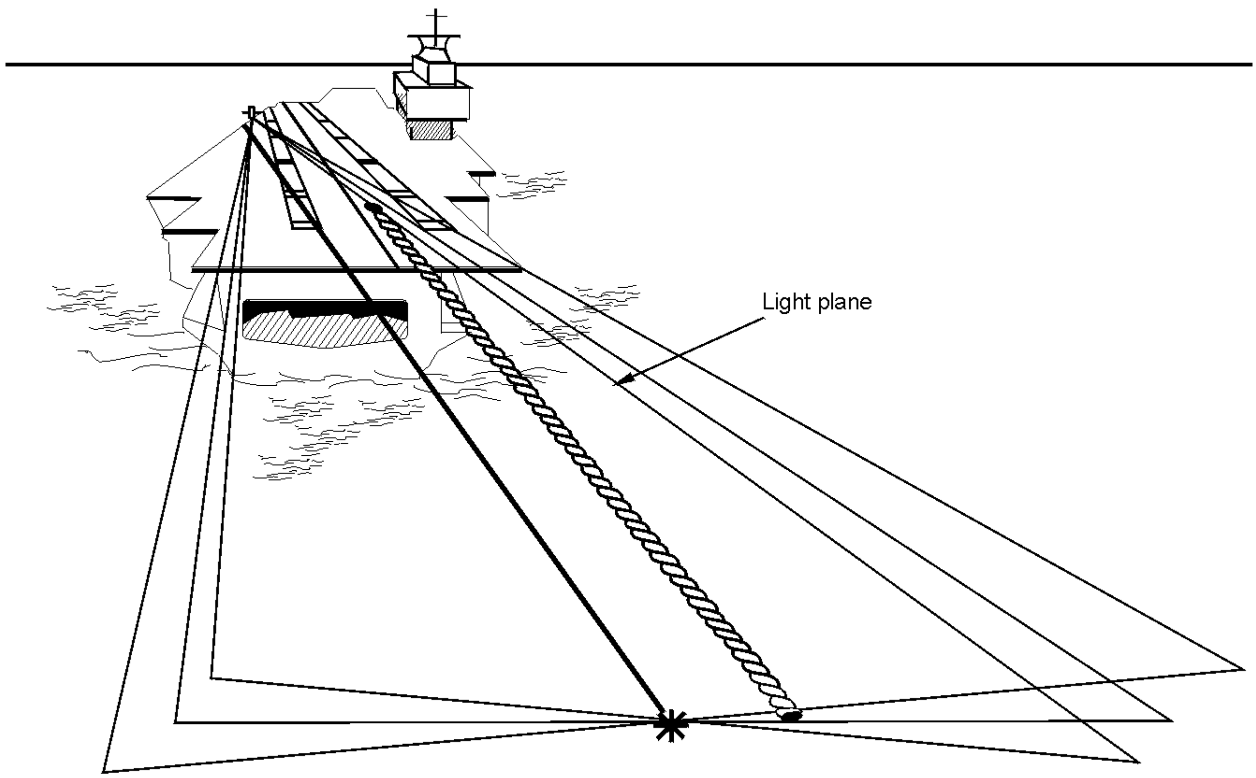


Figure 1-15 Effects of Roll Angle Changes on Light Plane

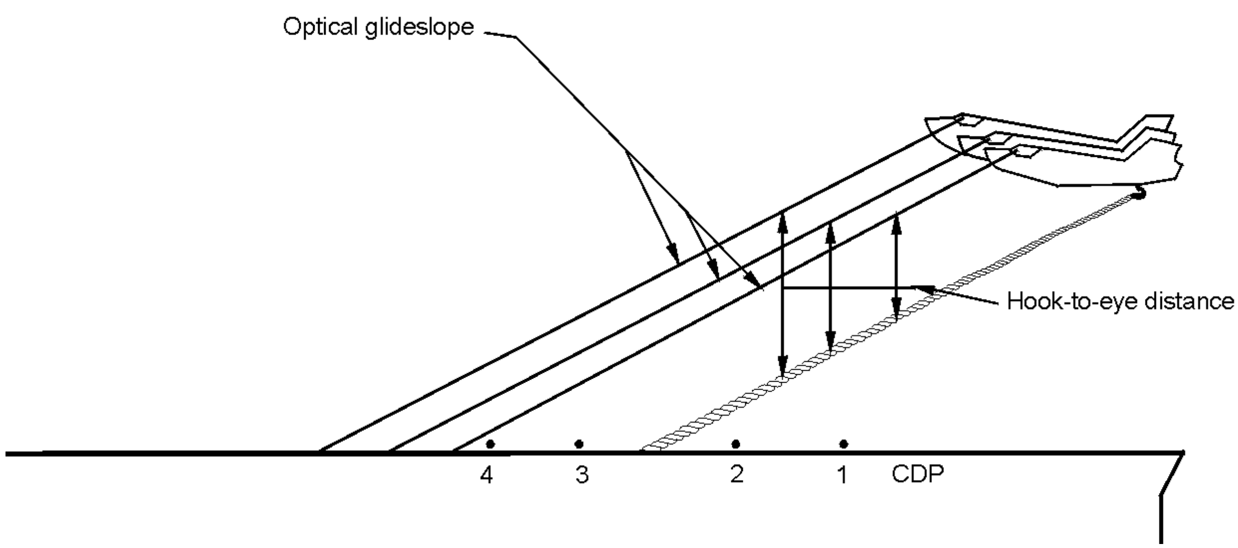


Figure 1-16 Glideslope Angles and Hook-to-eye Distances

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CHAPTER 2

Improved Fresnel Lens Optical Landing Aid System (Mk 13 MOD 0 IFLOLS)

2.1 GENERAL

IFLOLS will replace FLOLS on all Navy carriers and selected field carrier landing practice (FCLP) sites by the year 2002. It is a derivative of the Vertical/Short Take Off Landing (VSTOL) Optical Landing System (OLS) used aboard LHA and LHD class ships. It is presently installed on USS George Washington, CVN-73, and at NALF Fentress. Other ships will be equipped and 20 shore base units in FY '99-00.

2.2 ADVANTAGES

The main advantage of IFLOLS over FLOLS is that it allows the pilot to receive more accurate glide slope information from one mile out to touchdown. This is done by increasing the height of the lens from 50 inches to 72 inches, while making the same range of glideslope information as the "old' Mk-8 FLOLS thus increasing sensitivity, making the lens twelve vertical light cells tall rather than five. This gives the pilot a more accurate and earlier visual cue of ball movement, allowing him to correct quicker since the ball movement is more pronounced than in the present system. *(See Figure 2-1.)*

Other improvements that enhance IFLOLS capabilities are internal stabilization so that only the lens moves as it compensates for ship's movement rather than the entire platform, it uses fiber optics, is less sensitive to temperature, has printed circuit boards, and increases visual range due to improve optics. (Useable 1 1/4 - 1 1/2 miles out at night.) IFLOLS stabilization algorithms are digitized form of FLOLS algorithms with approximations replaced by "look-up" tables and known data points.

2.3 CHANGES

There are four wave-off lights, four emergency wave-off lights, and two cut lights per side of the indicator assembly. There is no change to the present MOVLAS.

2.4 PILOT TRANSITION

For pilots transitioning from FLOLS to IFLOLS, initial training shows that a pilot becomes comfortable with IFLOLS after three approaches and is confident of it in seven.

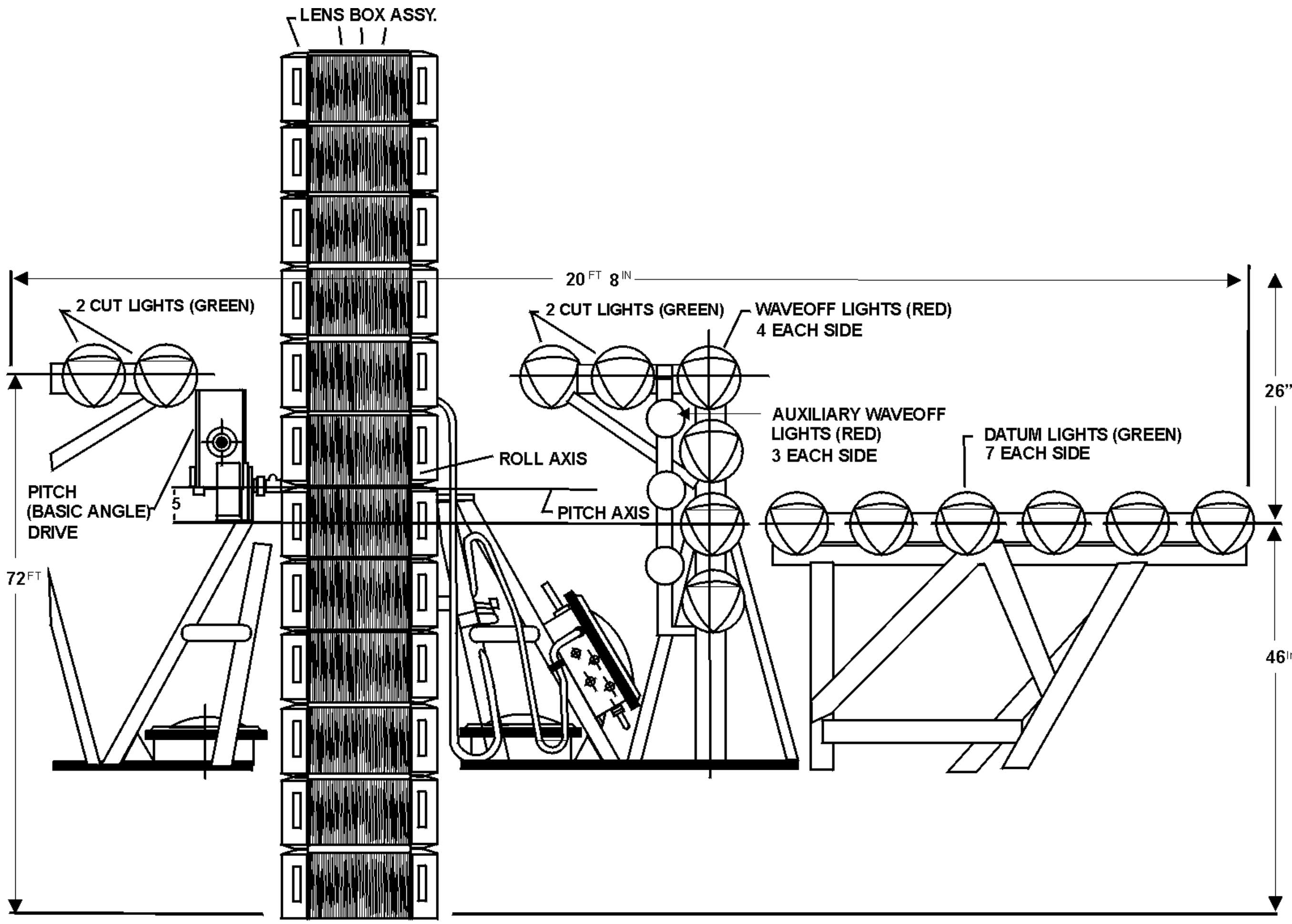


Figure 2-1 Mk 13 MOD 0 IFIDLS

CHAPTER 3

MANUALLY OPERATED VISUAL LANDING AID SYSTEM (MOVLAS)

3.1 GENERAL

The MOVLAS is a backup visual landing aid system used when the primary optical system (FLOLS) is inoperable, stabilization limits are exceeded or unreliable, and for pilot/LSO training. The system is designed to present glideslope information in the same visual form presented by the FLOLS. There are three installation modes aboard ship (*Figures 3-1 and 3-3):*

STATION 1: Installation is immediately in front of the FLOLS and utilizes the FLOLS waveoff, datum, and cut light displays.

STATION 2: Installation is completely independent of the FLOLS and due to cable resistance, must be located on the port side not less than 75 feet nor more than 100 feet aft of the FLOLS assembly.

STATION 3: Installation is mounted on a base assembly located on the flight deck on the starboard side. The approximate position is aft of the island and outboard of the safe parking line. The exact location can be located by the Air Officer, Aircraft Handler, LSO or other cognizant personnel (i.e., CAFSU). Utilization of this position may require on-deck aircraft movement.

3.2 MOVLAS CONSTRUCTION *(Figure 3-2)*

3.2.1 Light Box. The light box contains 23 vertically mounted lights which provide the meatball display. A set of perforated doors may be latched open or closed in front of the unit. When closed, the light intensity is decreased to approximately 3.5 percent of that with the shutters open. This doubles the range of light intensity control available from the power controller box and ensures adequate intensity range for day and night use. The bottom six lamps are red to provide coloring similar to the FLOLS low cell (they do not flash). Two toggle switches mounted on the LSO controller disable the bottom and uppermost three lamps respectively so that the meatball may be "run off" the top or bottom. LSO NATOPS requires the lower lamp disable switch to be in the "Enabled On" position at all times; an equipment change is proposed to remove or guard the switch from being placed in the off position.

3.2.2 Datum Box. A datum box unit is mounted on each side (Stations 2 and 3) of the light box and contains five separate datum lamps, four waveoff and one cut lamp. The single perforated door is used to increase the range of intensity control for the waveoff and cut lights. Perforated doors are used for all lamps which are not continuously lighted to ensure sufficient line voltage across the filaments to light the lamp instantly.

3.2.3 LSO Controller. The LSO controller is located at the LSO workstation. A handle is provided so the LSO may select the position of the meatball. The pickle switch is attached to the end of the controller handle. As the handle on the LSO controller is moved up or down it lights three or four consecutive lamps in the light box thus providing a meatball. Detentes are located at the horizontal, or centered ball position, and near the bottom just prior to the red ball going off the bottom.

3.2.4 Datum, Waveoff and Cut Lights. Independent controls are provided for intensity adjustment of the datum, source, and a combined control for the cut and waveoff lights. When activated, waveoff lights flash at a rate of 90 times per minute.

3.2.5 Repeater Light Box. Since controller detentes alone proved inadequate in use, service change 13 added a repeater light box to the system. The repeater monitors every other light on the light box and enables the LSO to visually ascertain the glideslope he is presenting to the pilot while facing the approaching aircraft. A separate MOVLAS repeater is integrated into the left side of the LSO HUD console. A small panel opens behind which there is a mirror which reflects the MOVLAS repeater image to the LSO. On/off and brightness controls for the HUD MOVLAS repeater are located on the HUD switch panel.

Shore based MOVLAS is compatible with the Mk 8 FLOLS, Mk 9 permanent mirror, and Mk 10 portable mirror or may be used independently.

3.3 MOVLAS CONSIDERATIONS

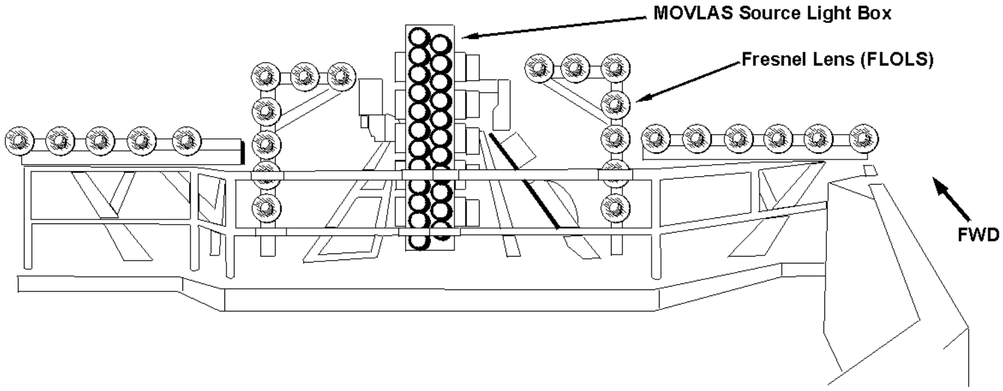
There are several important things to remember concerning the MOVLAS:

1. The MOVLAS should be properly protected from the elements when not in use since it is highly susceptible to water intrusion.
2. It takes practice to give good control and gain pilot confidence.
3. Ensure that all pilots are aware that MOVLAS is in use, that they do not attempt to fly with another aircraft in front of them on the ball. Consider the case where the first aircraft is too high!)
4. When the MOVLAS is installed Station 1, ensure the FLOLS source light is off to preclude double images.
5. Don't expect top pilot performance due to breakdown in normal scan pattern with the MOVLAS mounted Station 3 (starboard side), especially with left seat piloted aircraft.
6. Don't forget the radio. As an LSO, you have two methods to give the pilot information about his pass: your right hand with the MOVLAS handle and your left hand with the radio. USE THEM TOGETHER.
7. Position of the upper lamp enable/disable switch should be set in accordance with airwing policy. Note "Warning" in LSO NATOPS Section 6.4.10. The lower lamp switch should always be in the "on" or "enable" position.
8. LSO task loading during MOVLAS recoveries is extremely high, and scan breakdown can easily occur (e.g., deck status light, lineup, waveoff window). Backup LSO should be aware of increased potential of scan breakdown by controlling LSO.
9. Avoid tendency to stop moving MOVLAS control handle during LSO voice transmissions.
10. After aircraft touchdown, the control handle should be lowered to the full down position until the next aircraft is under LSO control.
11. Upon initiating a waveoff with the pickle switch, the LSO shall immediately transmit "waveoff" and lower the MOVLAS control handle to the full down position.
12. Avoid making abrupt ball movements in close that may induce excessive pilot corrections and undesirable sink rates.
13. During night/no horizon pitching deck operations, the LSO's ability to accurately determine and present glideslope information via MOVLAS is significantly reduced. Timely placement of a plane guard ship/helo or flares to give an artificial horizon may be a good idea.

3.4 REFERENCE INFORMATION

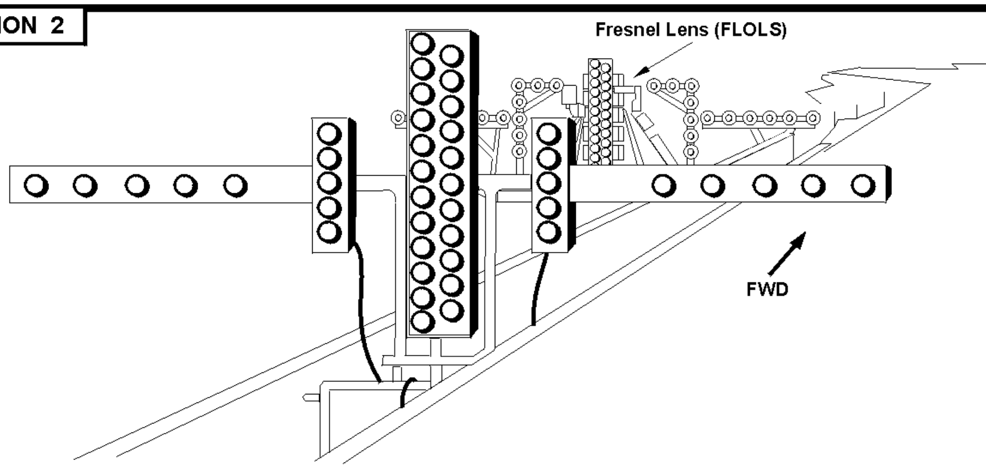
Information about the manually Operated Visual Landing Aid System (MOVLAS) can be found in NAVAIR 51-40ACA-3 (Mk 2 Mod 2 Landbased MOVLAS) or NAVAIR 51-40ACA-2 (Mk 1 Mod 2 Shipboard MOVLAS).

STATION 1



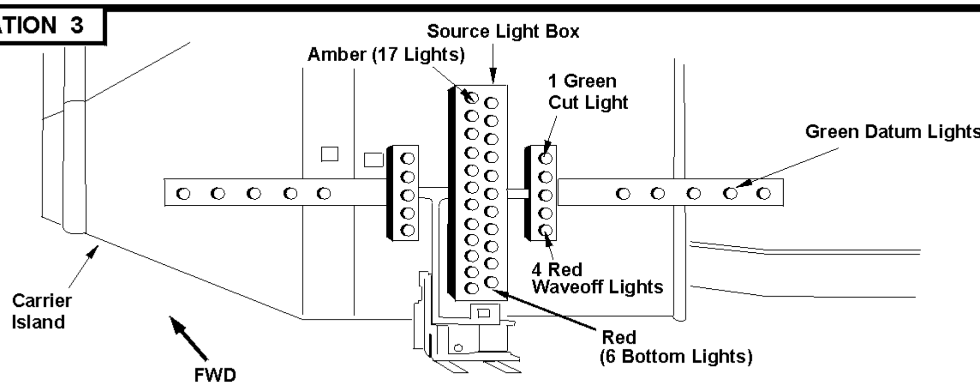
Station 1 MOVLAS utilizes the datum wave-off and cut lights of the Fresnel Lens Official Landing System.

STATION 2



Station 2 MOVLAS must be located between a minimumof 75 feet and a maximum of 100 feet aft of the Fresnel Lens.

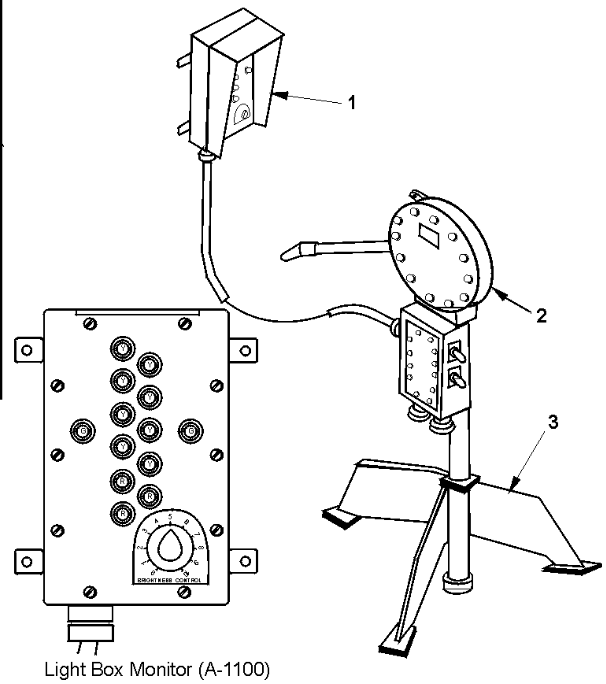
STATION 3



Station 3 MOVLAS is located on the starboard side of the flight deck aft of the island and outboard of the safe parking line.

Figure 3-1 Manually Operated Visual Landing Aid System (MOVLAS) Mk 1 Mod 2 General Arrangement (Shipboard)

INDEX NO.	DESCRIPTION	REFERENCE DESIGNATOR
1	Light Box Monitor	A - 1100
2	LSO Controller	A - 22A
3	LSO Controller STD	A - 900
4	L.H. Datum Light Box	A - 401A
5	Light Box	A100 - A
6	Datum Control Box	A - 500-A
7	Transformer Box	A - 601-A
8	R. H. Datum Box	A - 400A
9	Power Control Box	A - 300A
10	Base Assembly	A800
11	Bracket Assembly	A - 700
12	Datum Box Support	NONE



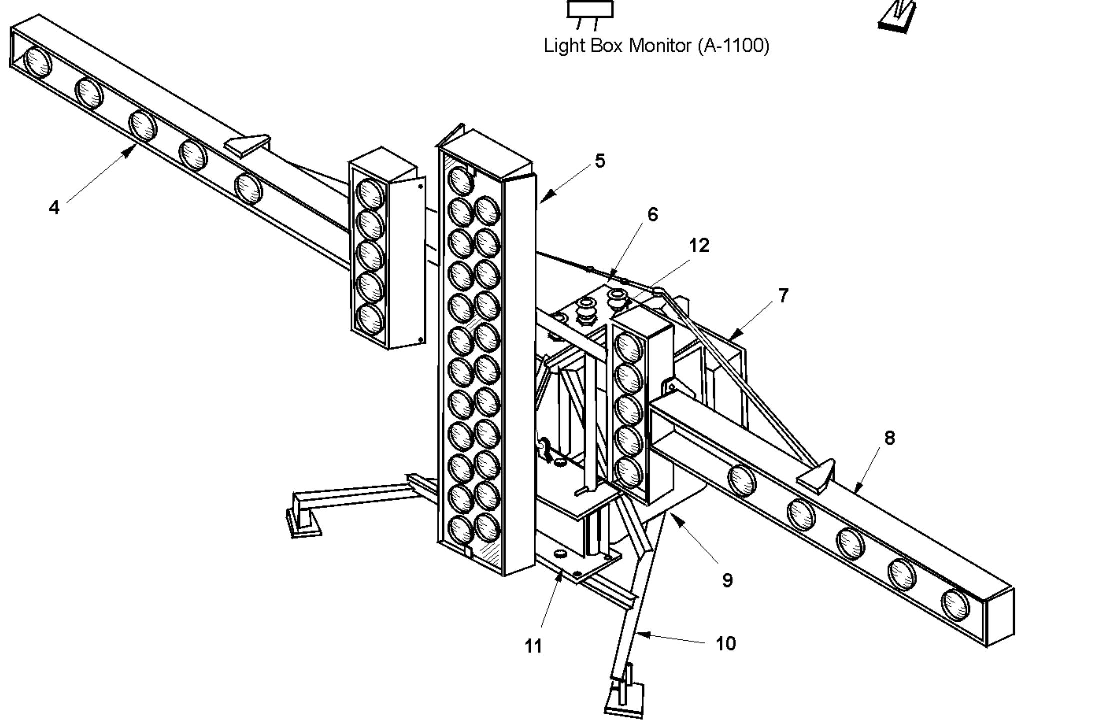


Figure 3-2 Mk2 Mod2 Manually Operated Visual Landing System (Shorebased)

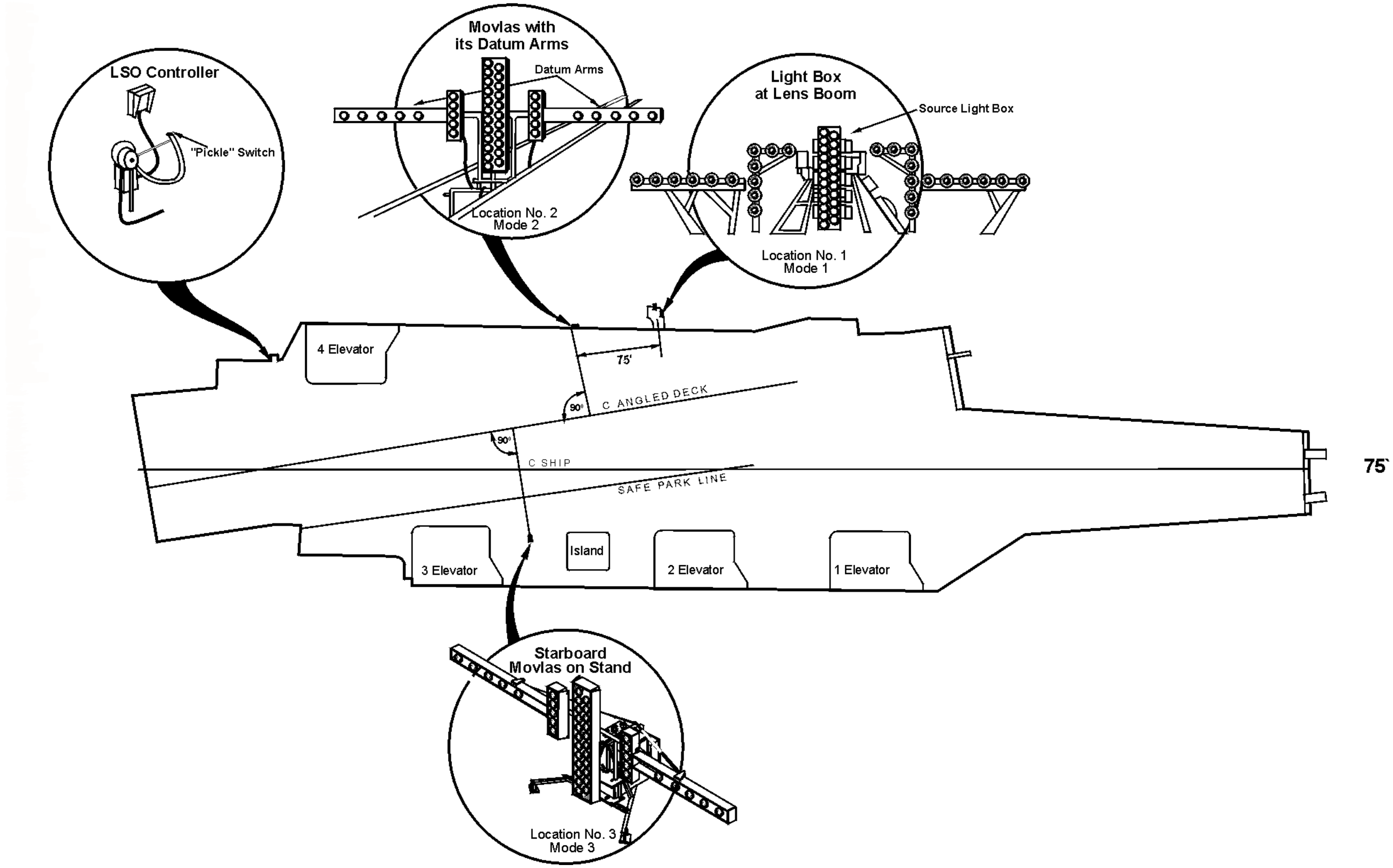


Figure 3-3 MOVLAS (Mk1 Mod2) Shipboard Installation

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CHAPTER 4

INTEGRATED LAUNCH AND RECOVERY TELEVISION SURVEILLANCE SYSTEM (ILARTS)

4.1 GENERAL

The Integrated Launch and Recovery Television Surveillance System (ILARTS) provides the LSO with a reference for aircraft lineup and glideslope information during recovery operations, and is used as a debriefing medium for pilots. Additionally, the system is used for recording significant flight deck events and, when necessary, for mishap or incident analysis.

4.2 ILARTS SYSTEM DESCRIPTION *(Figure 4-1).*

ILARTS is a completely integrated system of electronic pictures and sound recording equipment designed to monitor and simultaneously record aircraft launching and recovery operations under day and night conditions, and to play back the recording for postflight analysis and evaluation.

4.2.1 ILARTS Low Light Level Television Cameras. The system consists of television cameras with associated power supplies, monitoring, control synchronization and distribution equipment, and three video cassette recorders. At the heart of the system are the Intensified Low Light Level Television (LLLTS) Cameras, high resolution television systems optimized for night operations. These cameras incorporate the latest technology for detecting extremely low light level scenes and accurately converting them into usable video images. Two unmanned LLLTS cameras, each connected to a relay lens assembly, are installed approximately 40 feet apart in modified light wells on the flight deck centerline. Both cameras are located forward of the number 4 wire. One camera is used for normal operations, the other provides a backup capability in the event the primary camera becomes obscured or otherwise unusable. The centerline cameras are each equipped with automatic compressed air cleaning devices. Horizontal field-of-view is approximately 16 degrees.

4.2.2 Centerline Camera Stabilization And Crosshairs. The centerline cameras are equipped with the Electronic Crosshair Stabilization System (ECSS) which generates electronic reticles for glideslope and lineup reference. The vertical and horizontal reticles correspond with deck centerline and the aircraft glideslope (i.e., basic angle, but is set independently from the FLOLS). The intersection of the reticles is fixed at a point in space one million feet aft of the camera and at an elevation that corresponds with the selected basic angle. Reticle illumination is selectable; black for day, white for night.

The centerline lens assemblies receive their stabilization information from the ship's forward or aft gyro, or the CLASS system gyro. There are 2 modes of operation. In the normal mode, the carrier deck remains static while the reticles and landing aircraft move in unison with ship's pitch/roll excursions. Stabilization limits are +6° in pitch and +12° in roll. In the Image Motion Compensation (IMC) mode, landing aircraft and reticles remain in the center of the TV monitor display as the ship moves in pitch/roll. IMC limits are restricted to $\pm 2°$ in both axes.

NOTE

Hook contact with the centerline camera cover may misalign the camera reticles and provide erroneous information on ILARTS monitors. Since lineup is the primary information used by the LSO, the vertical crosshair should be adjusted prior to each recovery. Having an LSO trainee with a flashlight stand on the landing area centerline prior to the recovery is a good way to check the azimuth reticle on the LSO ILARTS monitor. An aircraft boresighted between the ILARTS crosshairs, if they are correctly calibrated, is on landing area centerline; aircraft position relative to optimum glideslope varies, however, and is a function of aircraft hook-to-eye value for the particular approach configuration.

4.2.3 Island Camera. An additional manned intensified LLLTS camera is located on the island structure, to pick up an aircraft as it passes over the centerline camera, zoom in for close-up identification of the aircraft, then follow the arresting wire back to indicate which pendant was engaged. In the event of a mishap, bolter, or waveoff, the island camera continues to record significant information.

4.2.4 ILARTS Data Generator. The ILARTS Data Generator superimposes ship identification, digital time (in thousandths of a second), wind velocity, SPN-42/46 aircraft true air speed, initiation of cut or waveoff lights, and deck status on a clear background on the upper part of the monitor simultaneously with the output of the centerline or island camera. With ILARTS service change 83, when installed, a MOVLAS repeater will become available on the data generator.

4.2.5 ILARTS Video Recording. The video cassette recorder records one video signal and two audio signals on a standard 60-minute reel of 3/4 inch videotape. This tape requires no processing and can be played back immediately. An integrated system of picture monitors provides line and replay coverage to all Ready Rooms, the LSO platform, Pri-Fly, Flight Deck Control, Flag Bridge, Captain's Bridge, Air Operations, ILARTS Control Room, and other remote sites.

Operators in the ILARTS/Lens Room perform several functions including selecting the various cameras for display and recording, recording land times for all aircraft, and recording which centerline camera is in use for each landing (fore or aft). The entire recovery is replayed to all ready rooms shortly after the last aircraft is on deck.

4.2.6 Additional ILARTS Capabilities. Bow and waist catapult surveillance cameras have been added to the ILARTS system. These cameras are equipped with infrared flood lights for night recording. This system is served by a separate video tape recorder. The primary purpose of the surveillance cameras is to record the catapult hook-up and launch sequence. The waist camera can also be used to record landings in the event of a dual centerline camera failure. Flight deck personnel should be warned not to look directly into the infrared radiation of these cameras as this can cause eye damage out to a distance of 10 feet.

"Joysticks" are installed on the ILARTS control console to provide a centralized control for operating the entire system. The ILARTS operator can easily select any camera view he desires to provide a video feed to the monitoring system.

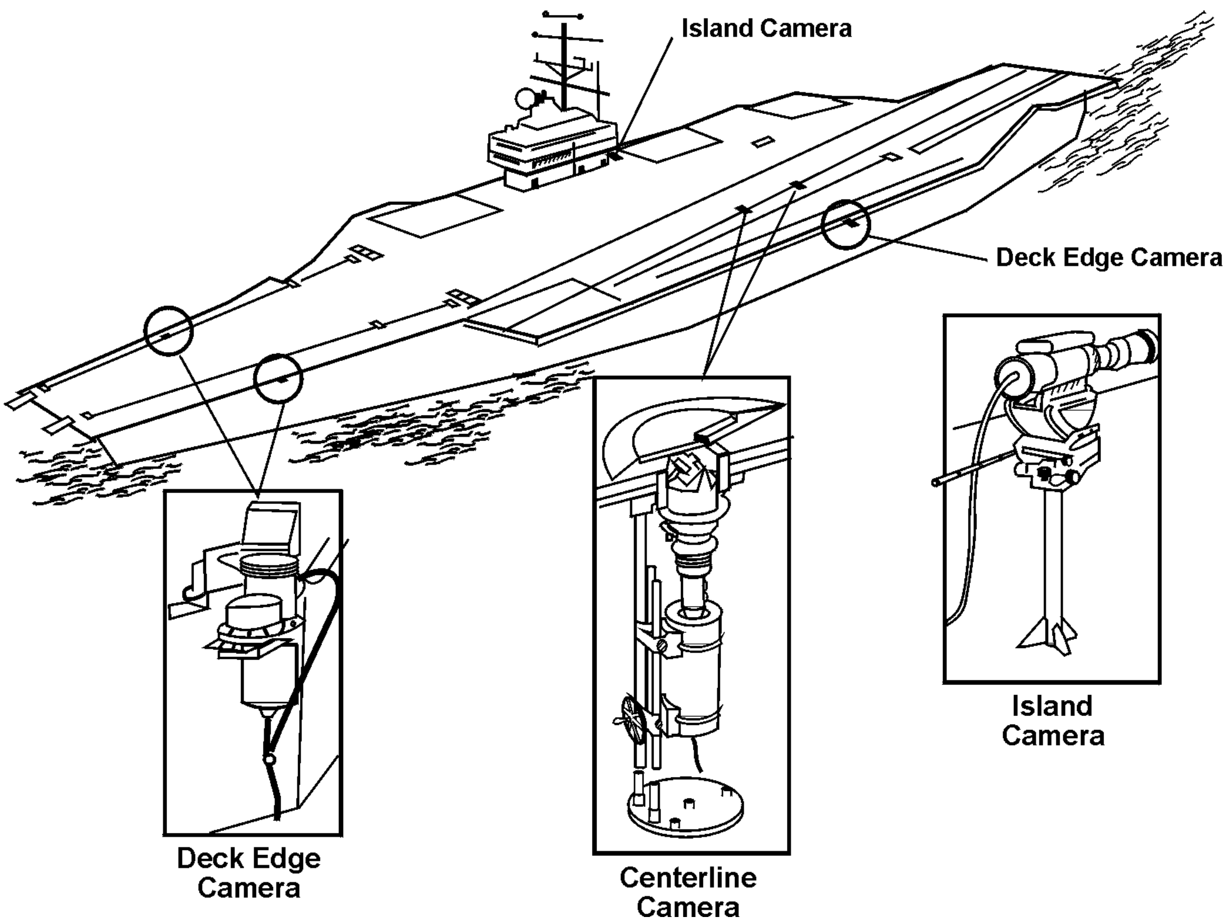


Figure 4-1 ILARTS Installation Location

CHAPTER 5

LSO WORKSTATION / EQUIPMENT

5.1 GENERAL

The LSO work station consists of three (3) pickle switches; a wind screen; LSO Base Console; and Heads-Up Display unit. As each of these components is discussed, it should be understood that each ship's configuration may vary in some small degree. *Figure 5-1* depicts the layout of a typical LSO platform.

5.2 LSO WORKSTATION COMPONENTS

5.2.1. Pickle Switches. The three LSO platform pickles are used to activate the waveoff and cut lights on the Fresnel lens or MOVLAS *(Figure 5-2)*. The pickles are for the use of the Air Wing LSO, the controlling LSO, and the backup LSO. Each assembly has a cord cable normally 10-20 feet in length. Two of the power receptacles for the pickle switches are located on the lower right side of the base LSO Base Console while the other is located underneath the lower HUD console, adjacent to the UHF handset receptacles. The switch and switch handle are made of a hardened rubber material and are susceptible to breakage with careless use or mishandling.

A thumb switch directly on top of the handle is used to activate the cut lights. The switch must be held down to illuminate the cut lights.

The switch inside the trigger guard activates the waveoff lights. Once the waveoff lights are activated they remain on until the switch is activated again. Since each of the pickle switches work independently, once the waveoff lights have been activated they can not be deactivated by either of the other two switches, but must be turned off by the same pickle that initially activated them.

Additional cut and waveoff switches are located on the Base Console in the lower right corner. To activate either the cut or waveoff lights the console switches must be depressed and **held down**.

NOTE

> The waveoff lights will function anytime they are initiated, whether or not the lens is on.

5.2.2. Windscreen. The windscreen is designed to protect the LSO from jet blast, high winds, rain,and non-skid. It is normally is 6 to 6½ feet in height and is hinged at the bottom to allow it to be lowered flush with the deck when not in use. The windscreen is made of heavy gauge steel and normally has two or three plexiglass windows to permit the LSO forward visibility into the landing area. It is normally raised and lowered by hydraulic power through a control box located adjacent to the platform on the deck edge. (The same control box is used to raise and lower the HUD console and the Base Console.) The control box may be stowed flush with the flight deck when not in use. In cases of hydraulic or electrical failure the screen may be raised and lowered manually.

NOTE

> When raising the windscreen, ensure the area is clear to prevent damage to aircraft or equipment.

5.2.3 LSO Base Console. The LSO Base Console *(Figure 5-3)* consists of numerous controls, communications equipment, indicators and fuses. This console may be several sub-assemblies, including the Stabilization remote Panel (CLASS Panel), FLOLS Lighting remote Panel, Connector Panel Assembly, Phone Panel assembly, 19MC Intercom Panel, Radio Set Control Panel (WSC-3), and Deck Status Light Control Panel. *Figure 5-4* identifies each of these sub-units and their relative location on the Base Console.

5.2.3.1 Stabilization Remote Panel A230A, Operating Controls and Indicators. The Stabilization Remote Panel A230A, or Carrier Landing Aid Stabilization System (CLASS) Panel *(Figure 5-5)*, on the LSO platform, is used primarily as a monitor of CLASS and has no direct control inputs. The panel contains a commanded hook-to-ramp clearance indicator (static and dynamic), commanded hook touchdown point indicator (static and dynamic), basic angle meter, hook-to-eye meter, ship's pitch and roll trim meters, a hook-to-ramp warning light and audible alarm, and a panel illumination control.

5.2.3.1.1 Stabilization Remote Control Panels A210/A220 (Pri-Fly and Lens Room Installations). The CLASS lens functions are normally controlled in Pri-Fly, with the Lens Room as a backup, using the Stabilization Remote Control Panel A210/A220. The control panel contains controls and indicators for all command functions of the Fresnel lens. The setting switches and indicator lights include an ENABLE switch which must be pressed before any command functions may be initiated, indicator lights that indicate which stabilization remote control panel (Pri-Fly or Lens Room) has been selected for system control, and an indicator light which indicates when a command is being initiated or changed. There are also various system status indicator lights. During normal operations in Pri-Fly (or Lens Room as a backup), the desired mode of stabilization (point or line) is selected using the STABILIZATION MODE switch; the basic angle is selected by depressing the desired COMMANDED HOOK PATH BASIC ANGLE DEGREES switch; the normal hook touchdown point is selected by depressing the HOOK PATH COMMAND /STANDARD switch; and the desired aircraft hook-to-eye value is selected by depressing the appropriate HOOK-TO-EYE DISTANCE - FEET (AIRCRAFT TYPE) switch. For hook touchdown points other than normal, such as for retargeting a new wire or barricade recovery, the NON STD HOOK PATH STATIC COMMAND switch must be selected as the NON STD SET/HOOK PATH STATIC COMMAND control is adjusted, observing the static commanded hook touchdown point indicator for the desired hook touchdown point. For non-standard hook-to-eye value adjustments, as for an aircraft with a configuration problem, the new value is set by depressing the DISPLAY DRIVE SIGNAL SELECT NON STD HOOK EYE DISTANCE switch while adjusting the NON STD SET/HOOK TO EYE DISTANCE control and observing the static commanded hook-to-ramp clearance indicator.

5.2.3.1.2 COMMANDED HOOK-TO-RAMP CLEARANCE and COMMANDED TOUCHDOWN POINT Indicators. The COMMANDED HOOK-TO-RAMP CLEARANCE and COMMANDED HOOK TOUCHDOWN POINT indicators are linear scale indicators which act as monitors of commanded hook path location relative to the ship and lens servo activity. The orange (dynamic) needles reflect the actual position of the lens interpreted in the form of commanded hook-to-ramp clearance and hook touchdown point. The orange needles provide a continuous monitoring of lens system status and servo performance, and indicate (by virtue of the motion amplitudes displayed) a measure of aircraft recovery difficulty.

The green (static) hook-to-ramp clearance and hook touchdown point indicators display values which are computed from lens positioning without the dynamic commands resulting from deck motion. They are relatively fixed, indicating static commands modified by the ship's trim position. The static COMMANDED HOOK TOUCHDOWN POINT indicator will remain fixed at the preselected commanded hook touchdown point. The static COMMANDED HOOK-TO-RAMP CLEARANCE indicator will vary slightly depending upon ship's static roll and pitch mistrim (confirmed by reading the SHIP TRIM ANGLES - DEGREES/PITCH and ROLL indicators) and selected lens basic angle. Any residual motion of the green needles is an indication of lens servo error.

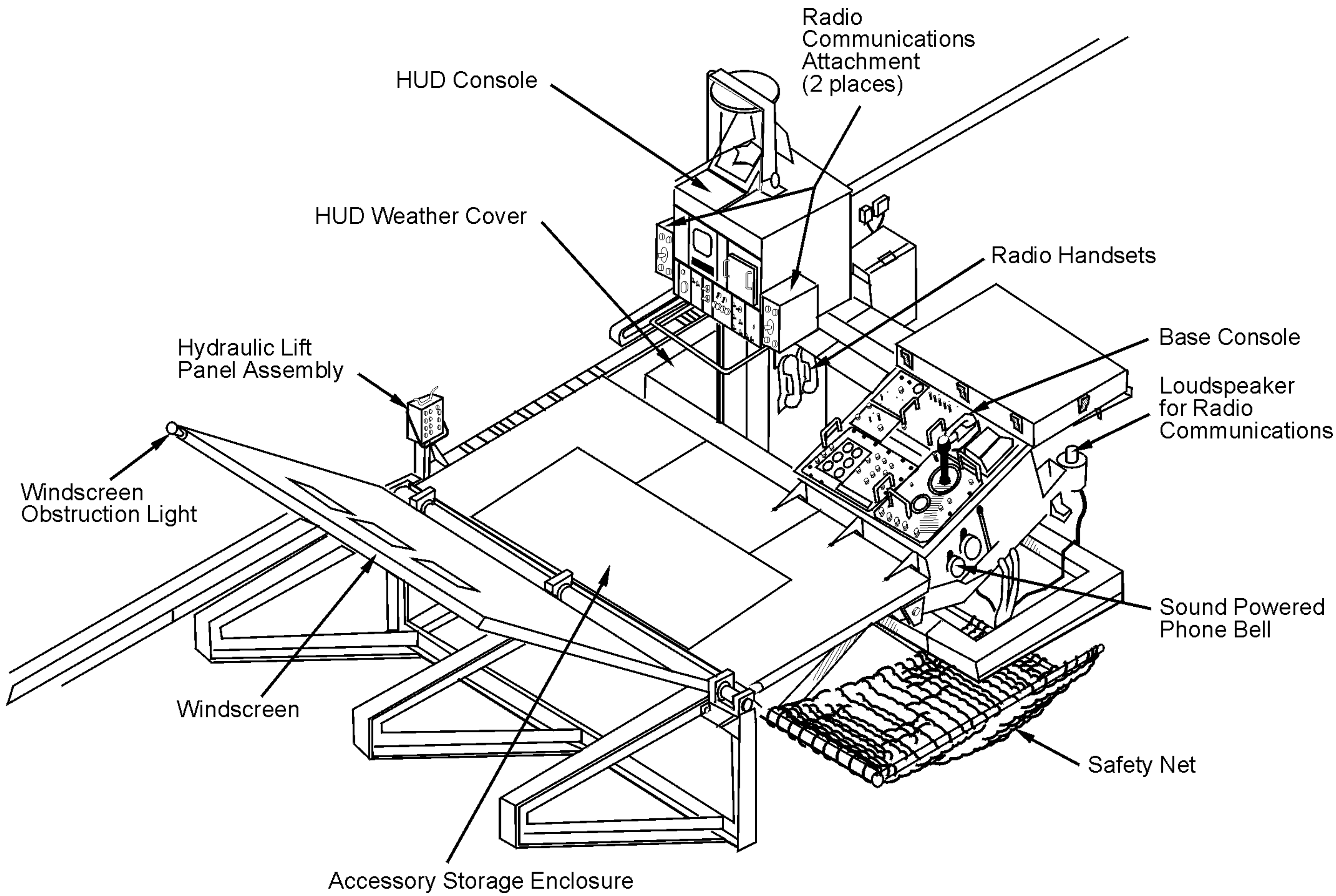


Figure 5-1 LSO Platform (with HUD and Base Console in Operational Position)

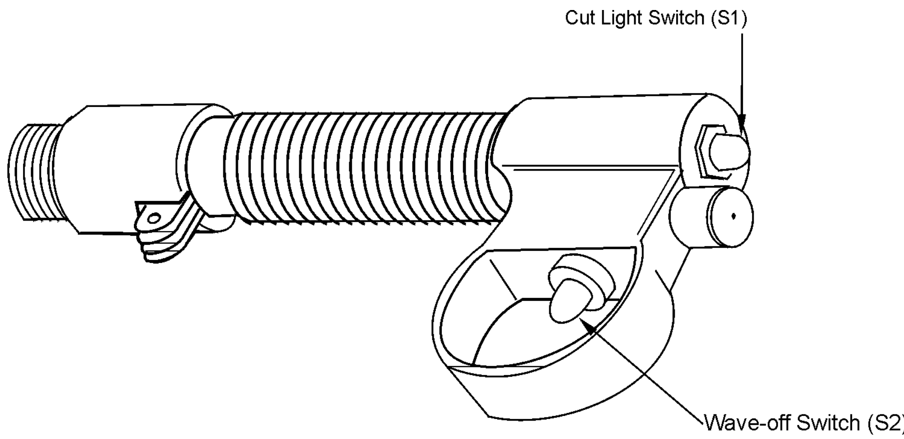


Figure 5-2 Portable (Pickle) Switch Assembly A330 and Components

CONTROL	USED
Cut light switch (S1)	When pressed to light cut lights
Waveoff light switch (S2)	When pressed to light or extinguish waveoff lights

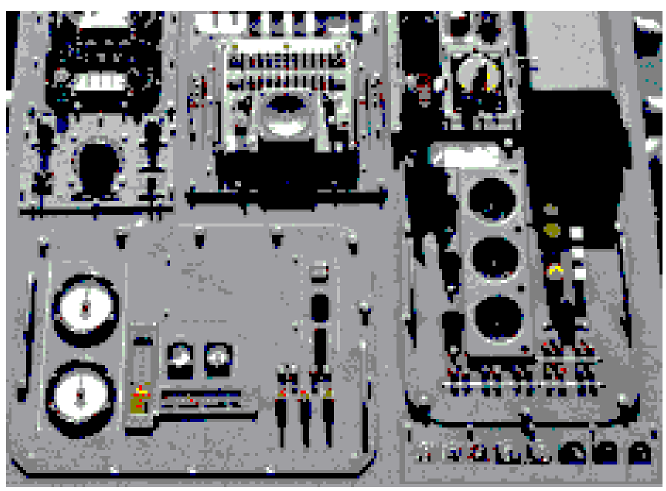
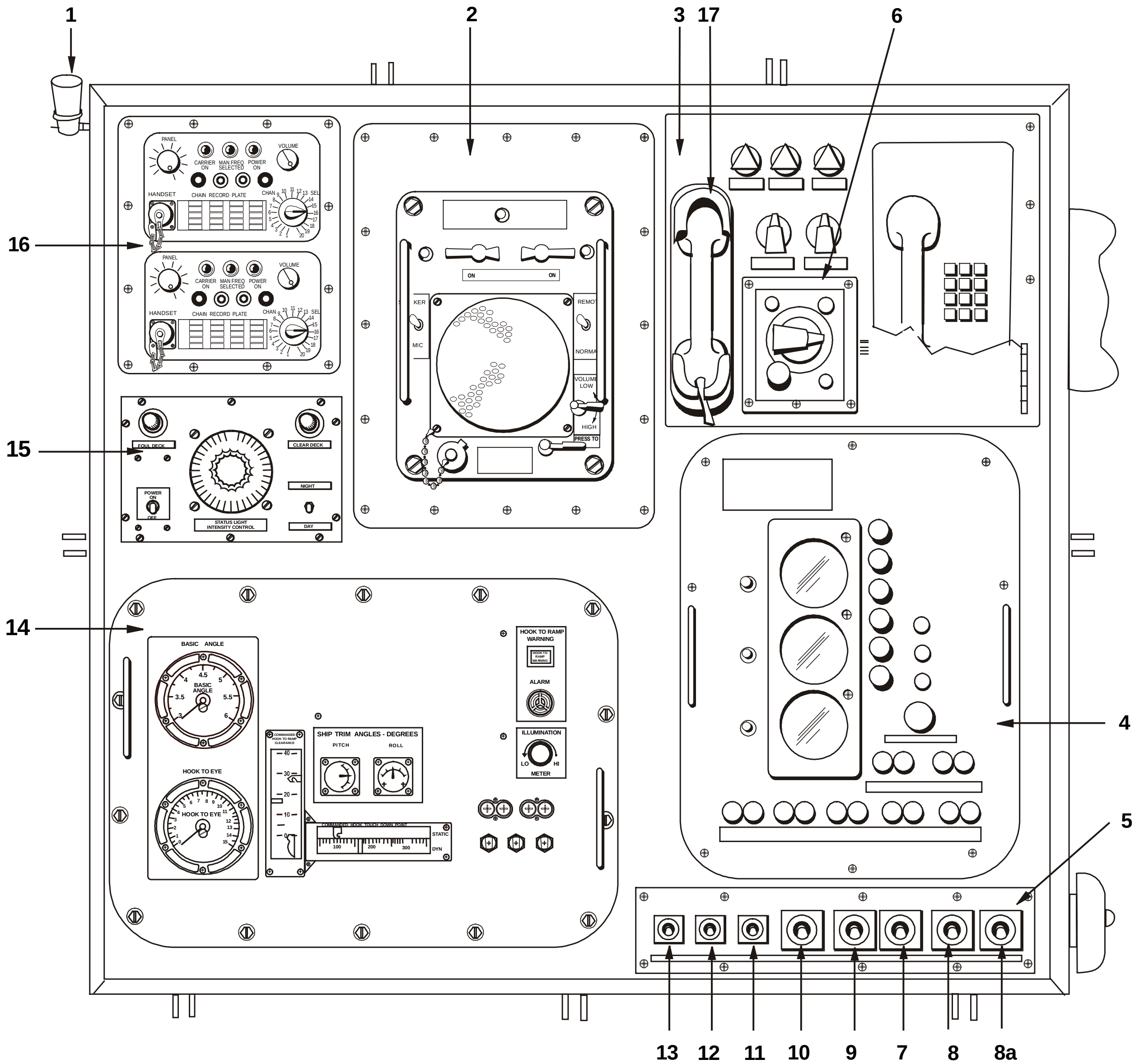


Figure 5-3 Typical LSO Base Console



1 Waveoff Monitor A740
2 19 MC Intercom Panel
3 Phone Panel Assembly
4 FLOLS Lighting Remote Panel A730A
5 Connector Switch Assembly
6 S.P. Phone Selector Switch
7 6 JG S.P. Phone
8 Pri-Fly S.P. Phone
8a S.P. Phone
9 Pickle Switch Receptacle
10 Pickle Switch Receptacle
11 ALDIS Light (28V) Receptacle
12 ALSO Radio (5 Pin) Receptacle
13 LSO Radio (5 Pin) Receptacle
14 Stabilization Remote Panel A230A
15 Deck Status Light Control Panel
16 Radio Set Control Panel (WSC-3 UHF)
17 Sound Powered Phone ("HOTLINE")

Figure 5-4 Typical LSO Base Console with CLASS Installed

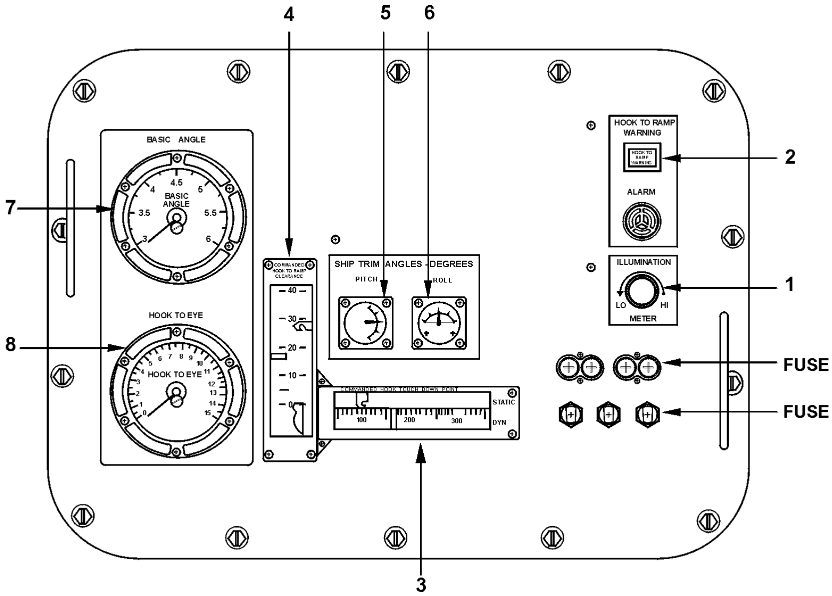


Figure 5-5 Panel Assembly, Stabilization Remote (A230A)

ILLUMINATION BRIGHT

1. METER Brightness Control (Variable Resister) — Used to adjust the brightness of the illumination for all meters and indicators.

   NOTE: The hook-to-ramp warning light is not affected by this control.

SYSTEMS STATUS

2. HOOK TO RAMP WARNING Indicator light — When on, indicates that the beam is commanding the aircraft too low with respect to the ramp (below 10 feet). Under condition of considerable ramp motion, the indicator light may turn on as the ramp clearance transiently drops too low.

COMMAND HOOK TOUCHDOWN POINT

3. HORIZONTAL Indicator — The green needle indicates the statically commanded hook touchdown point, unless the DISPLAY CHANGE WARNING light is illuminated. The orange needle indicates where the hook of an aircraft, flying on glideslope, will actually touch down.

COMMAND HOOK TO RAMP CLEARANCE

4. VERTICAL Indicator — In the standard hook-to-ramp clearance mode, the green needle indicates the statically commanded hook-to-ramp clearance unless the DISPLAY CHANGE WARNING light is illuminated. The orange needle indicates where the hook of the approaching aircraft, flying on glideslope, will pass over the ramp.

SHIP TRIM ANGLES - DEGREES

5. PITCH Indicator — Provides a continuous indication of the ship's pitch trim angles.

6. ROLL Indicator — Provides a continuous indication of the ship's roll trim angles.

7. Basic Angle Meter — Provides the basic angle setting readout from 3 to 6 degrees in one-quarter degree increments.

8. Hook-to-Eye Meter — Provides the hook-to-eye readout for specific aircraft from 10 to 20 feet.

FLOLS service change 119 incorporates a protective plexiglass environmental cover over the Basic Angle, Roll Angle (or Hook-to-Eye), Commanded Hook-to-Ramp Clearance, and Commanded Hook Touchdown Point gauges.

5.2.3.2 FLOLS Lighting Remote Control Panel A730A. *(Figure 5-6).* The Lighting Remote Control Panel is located on the lower right side of the LSO Base Console. It provides the current status of the FLOLS including controls and indicators for datum, cut and waveoff light intensity, low cell intensity, source light intensity, system go/no-go indicators, and pushbutton cut and waveoff light foot switches.

5.2.3.3 Deck Status Light Control Panel *(Figure 5-7).* The control panel for the Landing Area Status Light System is located on the left side of the LSO Base Console under the WSC-3 UHF Radio panel. This panel controls the two deck status light assemblies located on the port side of the landing area, aft of the LSO platform.

5.2.4 HEADS-UP DISPLAY UNIT *(Figure 5-8).*

5.2.4.1 General. The Mk 1 Mod 0 LSO Heads-Up Display system provides the LSO with aircraft, recovery, deck status, and trend information in a consolidated display. It provides the LSO a dynamic visual display of all critical aircraft landing factors, allowing the LSO to make more timely judgments concerning the safety of recovery operations and the quality of an aircraft approach. In normal operations, the LSO stands in front of the HUD Console, facing the aft end of the carrier flight deck. In this position, the LSO can get a direct view of the approaching aircraft and, with only a slight shift in scan, may also see all HUD Console displays. The LSO may easily rotate or "pan" the HUD to keep both the aircraft and console displays in his field of view. All console controls are within arm's reach on the front panel, and are back-lighted for night viewing. The major elements of the LSO HUD are the Display Subsystem, the Hydraulic Lift Subsystem, and the Test Simulator.

5.2.4.2 HUD Display Subsystem. The Display Subsystem is comprised of components which receive data signals from various existing shipboard equipment and process them for display. The HUD is actually two separate displays - the lower display on the front of the HUD console, and the upper Heads-Up Display, located on top of the HUD console.

The HUD lower (panel mounted) display *(Figures 5-9 through 5-11)* contains secondary and augmenting readouts for the LSO. The console is equipped with a panning head so that the direction and elevation may be adjusted as necessary. Panel mounted displays include:

1. Range (0 to 6NM)
2. Rate of descent (0 to 2000 FPM)
3. Ramp motion (0 to $\pm$ 20 ft)
4. SPN-42/46 or SPN-44 derived true or closing airspeed (80 to 180 KTS)
5. Radar and airspeed type selection indicator
6. Deck status and FLOLS waveoff status indicator
7. Wind direction (0 to 50 degrees, port or starboard, relative to the landing area centerline)
8. Wind speed (0 to 99 KTS)
9. Type aircraft indicator (4 alpha-numeric characters)
10. PLAT/ILARTS centerline camera monitor
11. MOVLAS repeater display
12. ACLS status indicator (approach mode and waveoff)

Aircraft position, range, and rate of descent are derived from SPN-42/46 radar inputs. Ramp motion and trim signals are derived from the Mk 6 Mod 3 FLOLS. True or closing airspeed is derived from a selection of SPN-42/46 or SPN-44 inputs. Panel and enclosure mounted accessories include the console operating controls, a type LS458/51C (21MC) intercom station to Pri-Fly and CATCC, a console obstruction light, and externallymounted radio handsets and pickle switches.

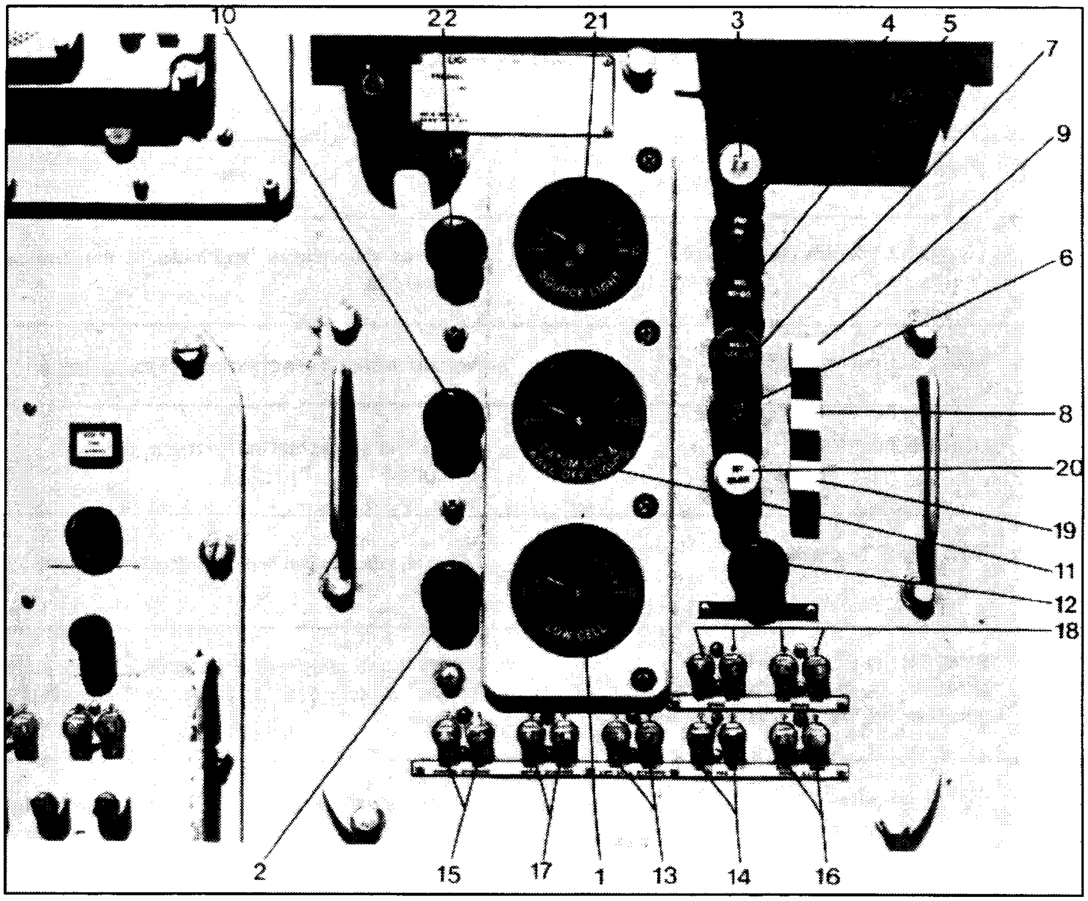


Figure 5-6 Lighting Remote Control Panel A730A

Index **No.**	**Control, Indicator, or Fuse**	**Index No.**	Control, Indicator, or Fuse
1	LOW CELL intensity dial indicator	12	PANEL ILLUM control
2	LOW CELL intensity control	13	LOW CELL SYNCHRO fuses
3	UNIT ON indicator	14	28 VDC fuses
4	SYSTEM GO indicator	15	SOURCE SYNCHRO fuses
5	SYSTEM NO-GO indicator	16	PANEL ILLUM fuses
6	CUT LT indicator	17	DATUM SYNCHRO fuses
7	WAVEOFF LT indicator	18	SPARE fuses
8	Cut light push-button switch	19	Brightness select push-button
9	Waveoff light push-button switch	20	BRT SELECT indicator
10	Datum, cut, and waveoff lights intensity control	21	SOURCE LIGHT intensity dial indicator
11	DATUM CUT & WAVEOFF LIGHTS intensity dial indicator	22	Source light intensity control

FLOLS LIGHTING REMOTE CONTROL PANEL A730A

Fig 5-6 No.	Control, Indicator, or Fuse	Use
1	LOW CELL intensity dial indicator	Indicates the relative brightness of the low cell source lights.
2	LOW CELL intensity control	Varies the brightness of the low cell source lights.
3	UNIT ON indicator	When lit, indicates that the Fresnel system is energized.
4	SYSTEM GO indicator	When lit, indicates that the Fresnel system is functioning properly.
5	SYSTEM NO-GO indicator (Note: If both SYSTEM GO and NO-GO are lit, the lens stow lock has not been removed.)	When lit, indicates that a malfunction exists in the Fresnel system and the system will not function properly.
6	CUT LT indicator	When lit, indicates that cut lights on deck-edge assembly are on.
7	WAVEOFF LT indicator	When lit (flashing), indicates that waveoff lights on deck-edge assembly are on.
8	Cut light push-button switch	When pressed and held, lights the cut lights.
9	Waveoff light push-button switch	When pressed, lights the waveoff lights
10	Datum, cut, and waveoff lights intensity control	Varies the brightness of the datum, cut, and waveoff lights.
11	DATUM CUT & WAVEOFF LIGHTS intensity dial indicator	Indicates the relative brightness of the datum, cut, and waveoff lights.
12	PANEL ILLUM control	Varies the intensity of the dial indicator lights and panel lights.
13	LOW CELL SYNCHRO fuses	Protects low cell synchro from current overload.
14	28 VDC fuses	Protects source, datum, cut, waveoff, and low cell clutches from current overload.
15	SOURCE SYNCHRO fuses	Protects source light synchro from current overload.
16	PANEL ILLUM fuses	Protects panel illumination transformers from current overload.
17	DATUM SYNCHRO fuses	Protects source, datum, cut, and waveoff lights synchro from current overload.
18	SPARE fuses	Contains spare fuses
19	Brightness select push-button	When pressed and held, give momentary control of all lens light intensity controls to LSO panel.
20	BRT SELECT indicator	When lit, indicates that the light intensity control circuits are enabled and can be operated from LSO panel.
21	SOURCE LIGHT intensity dial indicator	Indicates the relative bightness of sorce lights other than the low cell source lights.
22	Source light intensity control	Varies the brightness of source lights other than the low cell source lights.

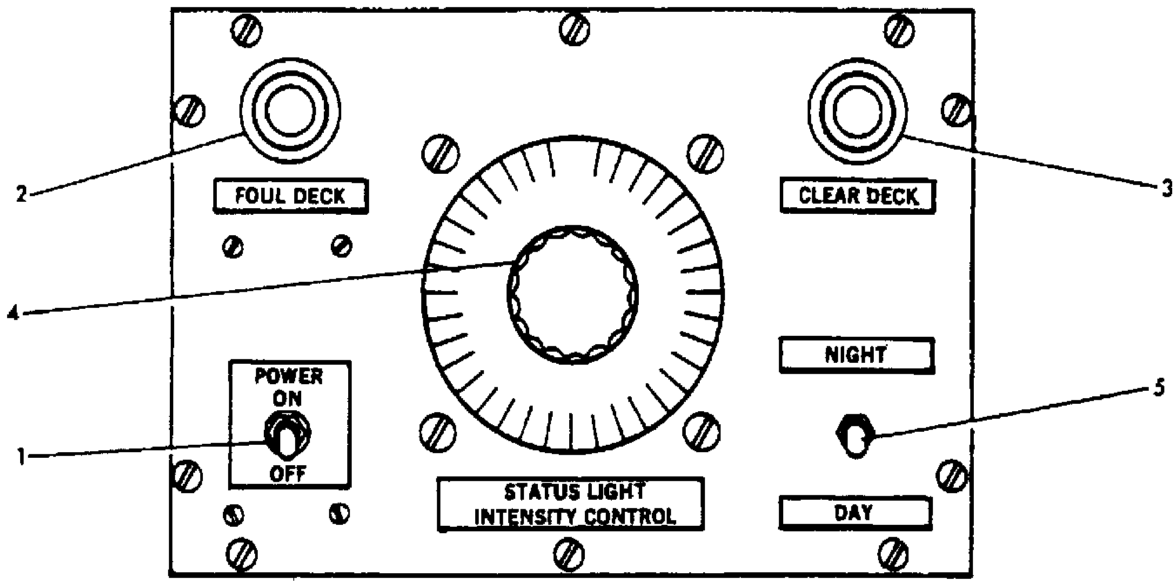


Figure 5-7 Landing Area Status Signal System Control Panel

ITEM NO.	NOMENCLATURE/ TYPE CONTROL	FUNCTION
1	POWER ON/OFF, Toggle Switch	Status light power ON/OFF switch
2	FOUL DECK, Indicator Light (Red)	When illuminated, indicates that landing area status light is red
3	CLEAR DECK, Indicator Light (Green)	When illuminated, indicates that status light is green
4	STATUS LIGHT INTENSITY CONTROL, Variable Transformer	Controls intensity of landing area status lights
5	DAY/NIGHT, Toggle Switch	Transfer switch. When set to DAY position, it enables 150 watt status lights; when set to NIGHT position, it enables 50 watt status lights

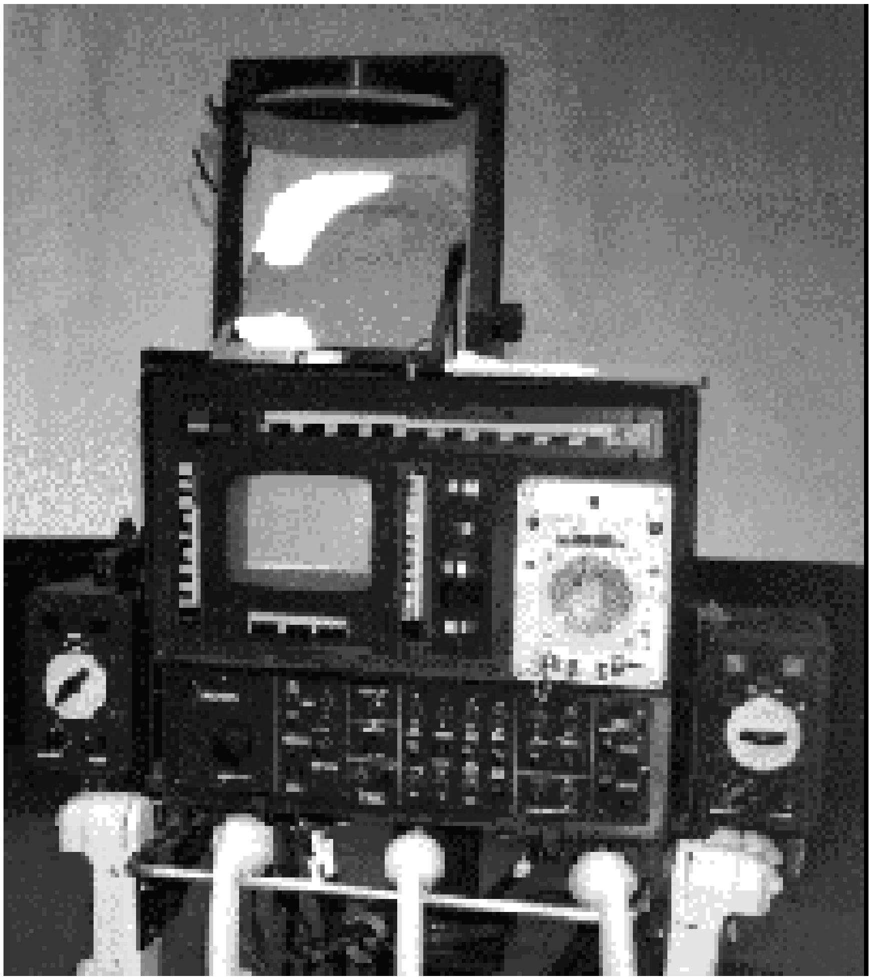


Figure 5-8 Heads-up Display (front view)

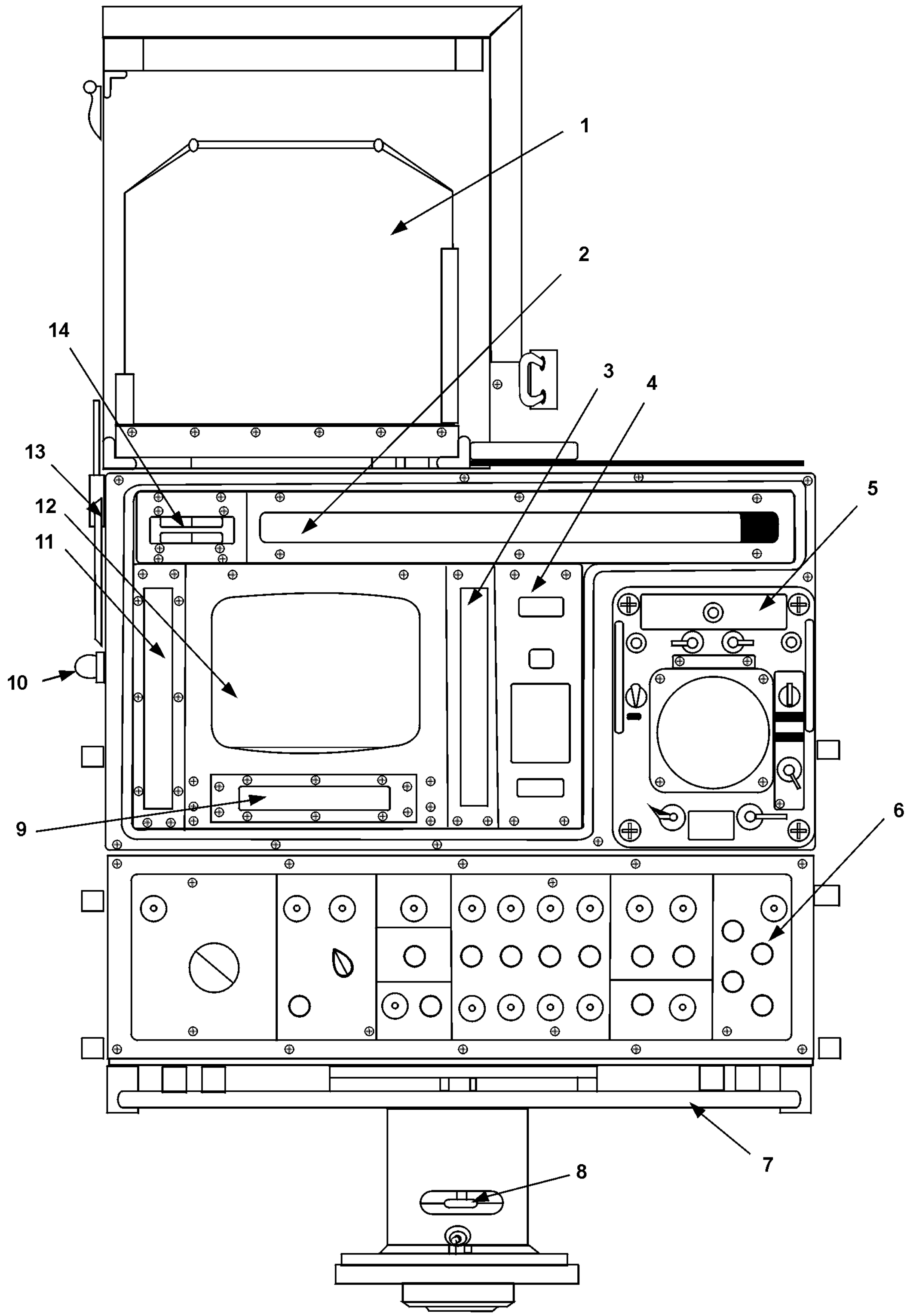


Figure 5-9 LSO Heads-UP-Display (HUD) Front View

HUD Console, Controls and Indicators
(Except those on Control Panel)

Nomenclature	Fig. 5-9 Index No.	Purpose
Heads-up-Display	1	Presents an aerial image of computer-generated, realtime aircraft landing data.
Airspeed Indicator	2	A white pointer light moves across a horizontal Indicator scale, indicating approaching aircraft airspeed between 80 and 180 knots. An adjacent "trend light", at half intensity, <u>follows</u> the pointer light indicating whether the airspeed trend is increasing or decreasing. Either true airspeed or closing airspeed may be selected for presentation by means of a control-panel toggle switch. Another control panel toggle switch selects the output of either the ship's SPN-46 radar SPN-44 radar. Typical displays are: CLSG 44, or TAS 42.
Rate of Descent Indicator	3	A white pointer light moves on vertical scale between 0 and 2,000ft/min with a resolution of 50ft/min. An adjacent "trend light", at half intensity, <u>follows</u> the pointer light indicating whether the rate of descent is increasing or decreasing. An illuminated marker at 700 ft/min indicates the optimum rate of descent. Identical data appears or the Heads-Up display.
ACLS Indicator Assembly	4	Four separate indicators are housed in this assy. From top to bottom, they are: a. Wind angle: indicated by a P for port, or an S for starboard, followed by a two-digit number indicating degrees, relative to the angled landing deck. Typical displays are S 12, or P 25. b. Wind speed in knots: indicated by a two-digit number. A typical display: 35. c. Automatic Carrier Landing system (ACLS) status. When an aircraft is acquired, a LOCK-ON indicator is illuminated, as well as one of three mode indicators: A green mode I indicates full ACLS-controlled landing. A white mode II indicates a pilot/ACLS-controlled landing. Or, a white mode III indicates an ACLS instrument readout/pilot landing. The ACLS system generates a wave-off when computer and radar data or aircraft response is questionable. An ACLS wave-off signal is indicated by a blue flashing WAVE-OFF display below the Mode indicators. The LOCK-ON indicator also lights when the HUD DISPLAY switch *(3, Figure 5-10)* is turned to SET INTENSITY or TEST positions. d. The type of approaching aircraft is indicated by one alpha and one or more numeric characters in an illuminated display, such as A 6.
Intercom	5	A modified LS-458/5IC; provides hands-free voice communication with PRI-FLY CATCC
Control Panel	6	On/off switches and controls for all displays with in the HUD console. See *Figure 5-10*
Carrying Bar	7	Front and rear bars facilitate rapid console positioning during operations.
Pan-Lock Handle	8	Enables LSO to lock console in desired operational position, horizontally.

HUD Console, Controls and Indicators
(Except those on Control Panel) (Cont.)

Nomenclature	Fig. 5-9 Index No.	Purpose
Range Indicator	9	A white pointer light moves across a horizontal scale, indicating approaching aircraft range of 6 miles and less, with a resolution of 0.2 nautical miles.
Obstruction Light	10	Lights when console is not stowed and console power is off. At night, enables flight deck personnel to see that the console is up, even when no console displays are operational.
Ramp Motion Indicator	11	A white pointer light moves on a Indicator vertical scale between -20 and +20 ft, with a resolution of 1 ft. The high-ramp scale between +10 and +20 ft is covered with a red filter, indicating danger and the possibility of a ramp strike by approaching aircraft. In normal operation, the pointer light displays the sum of ramp motion due to the sea and any fixed displacement due to the ship's trim. However, operation of a momentary control-panel toggle switch displays only the displacement due to the ship's trim. At such time, a TRIM lamp lights on the vertical scale. Identical ramp and trim data appears on the HUD display.
Pilot Landing Aid Television (PLAT) Monitor	12	Presents a picture of the approaching aircraft as seen by the centerline television camera on the flight deck.
MOVLAS Indicator	13	Small lights display for the LSO the same pattern of lights seen by approaching pilot as he views the Manually Operated Visual Landing Aid System (MOVLAS). *(Figure 5-11)*
Deck Status & Fresnel Lens Optical Landing (FLOLS) Wave-off Indicator	14	A green CLEAR DECK indicator advises the LSO that the deck is free of obstructions and is ready for an aircraft landing. A red FOUL DECK indication advises the LSO that the deck is not ready for an aircraft landing. When the LSO actuates the FLOLS "pickle switch", a flashing red WAVE-OFF indication advises the LSO that the FLOLS system is functioning.
Polarized Filter	15	Covers front panel indicators; improves legibility of (Not Shown)
Red Filter		Covers PLAT Monitor; improves legibility of TV picture (Not Shown) at night. Attaches magnetically, removes easily. Store in filter holder on console back plate.
Neutral Density Filter (not shown)	17	Covers ACLS indicator assy; improves legibility of indicators at night. Attaches magnetically, removes easily. Store in filter holder on console back plate.

Two filters may be easily attached to improve nighttime viewing of the PLAT monitor and ACLS indicator module.

The upper HUD display *(Figures 5-9 and 5-12)* contains critical recovery data which has been projected by a cathode ray tube through a special lens onto a combiner glass. Displayed information includes:

1. Glidepath and lineup (aircraft symbol movement relative to axes, in feet)

2. Range (1NM and under)

3. Ramp motion and trim (feet)

4. Rate of descent (200 to 1500 FPM).

Rate of descent and ramp motion/trim scales are facsimiles of the indicators on the lower HUD panel. Glidepath and lineup information is derived from the SPN-42/46 system, where inputs are used to generate projections of an aircraft position symbol ("bug") relative to the vertical (lineup) and horizontal (glidepath) reference datums. Range information is also SPN-42/46 derived, displayed by an arc, centered at the intersection of the reference axes.

The arc appears as a full circle at a range of 1NM, and proportionately decreases counterclockwise to zero at the ramp. A filter may be attached to the back of the combiner glass for daytime viewing.

5.2.4.3 Hydraulic Lift Subsystem. The Hydraulic Lift Subsystem provides a means for raising the HUD Console to an adjustable height to accommodate viewing by the LSO on the platform. It also provides for lowering the HUD Console to an unobstructing level below the flight deck, into a storage enclosure.

5.2.4.3.1 Controls and Components. The hydraulic lift employs a hydraulic circuit in which a rotary pump, driven by an electric motor, provides pressurized fluid to a hydraulic piston that raises and lowers the HUD Console. A directional control valve, activated from the lifting system control panel, routes hydraulic fluid to either the bottom or top end of the cylinder to raise/lower the HUD Console. Hydraulic circuitry is also provided to deploy and stow the LSO platform windscreen and LSO Base Console. Electrical interlocks are used to:

1. Prevent raising the HUD console before the windscreen is raised.

2. Prevent lowering the windscreen before the HUD console is lowered.

3. Prevent raising the HUD console with the weather cover lid down.

4. Prevent lowering the HUD console when it is misaligned with its weather cover.

5.2.4.3.2 Emergency Operation. An emergency procedure exists to operate the system in the event of an electrical failure. The lift system may be operated by using a compressed air motor to drive the hydraulic pump, and the directional control valve may be operated manually. However, the limit switch safety interlocks are not operable.

5.2.4.3.3 Hydraulic Lift Control Panel. The Hydraulic Lift Control Panel *(Figure 5-13)* is mounted just inboard of the LSO's normal position on the platform. The HUD Console may be raised/lowered by pressing lighted pushbutton switches on the control panel, or by operating a pendant switch at the end of an eight foot cable attached at the HUD Console itself.

5.2.4.4. Test Simulator. The Test Simulator is a special purpose test set designed specifically to generate signals simulating those which, during recovery operations, are fed from the ship to the HUD Console. A single technician is able to feed and monitor signals from the Test Simulator to the HUD Console for the purposes of setup, calibration, or troubleshooting.

5.2.4.5 Reference Information. Additional information on the LSO HUD may be obtained from NAVAIR 51-60-9 (Installation, Operation, and Maintenance Instructions for Landing Signal Officer Heads-up Display Console System, Mk 1 Mod 0, and HUD Console Test Simulator, A/E-24T-145).

5.2.5 Communications Equipment. LSOs need to be familiar with the various means of communication aboard the ship, in addition to having an understanding of the communication equipment available on the LSO platform.

5.2.5.1 Air Department Equipment. The Air Department passes information via the following manned sound-powered circuits (no electricity required) during flight-quarters:

1JG-aircraft control: Flight Deck Control
Hanger Deck Control
Pri-Fly
Fly I,II,III
Elevators 1, 2, 3, & 4 (upper & lower stations)
LSO Platform
Air Operations
Other miscellaneous stations

2JG-aircraft information: Flight Deck Control
Air Operations
CCA
Ready rooms
Meteorology
Other miscellaneous stations

Additional Circuits

3JG -	Sound powered "hot line" to LSO
4JG -	Aircraft fueling
5JG -	Ordnance
6JG -	Arresting gear
X21JG -	Catapults
10JG -	Captain's chair, Pri-Fly, Air operations, Strike Operations
11JG -	(manned during night/IFR recoveries only) CCA, FLOLS controller, Pri-Fly, LSO Platform

5.2.5.2 Deck Announcement Systems. There are two deck announcing systems which are used during routine operations:

1. 3MC is the Hanger Deck announcing system and is controlled from Pri-Fly, Hanger Deck Control, and all conflagration stations.

2. 5MC is the Flight Deck announcing system and is controlled from Pri-Fly or Flight Deck Control. Word passed over the 5MC is automatically transmitted over SRC-22 systems (flight deck Mickey Mouse headsets).

5.2.5.3 Shipboard Intercommunications. Shipboard intercommunication systems include the following:

1. 19MC connects Air Department control stations with Air Operations, ready rooms, CVW office, LSO platform, meteorology, Strike Operations, Flight Deck Control, and others. It is incorporated in the LSO Base Console.

2. 21MC connects Pri-Fly, CATCC and the LSO platform. It is incorporated in the HUD system console.

5.2.5.4 LSO UHF Communications. The LSO has two primary means of UHF communication, CATCC radios (primary) and WSC-3 (backup) radios. Radio selector control is accomplished by barrel switches located on either side of the LSO HUD console. The left side selector control is for the controlling LSO, the right side selector is for the backup LSO ("ASST LSO"). Depending on the position selected for each of these barrels, each LSO may communicate on the same or, if desired, a different frequency from the other LSO. Separate handset volume controls are also provided on the control boxes.

5.2.5.4.1 CATCC Radio. The "Final A" or "Final B" position of these barrel switches, LSO UHF communication is through the CATCC radios on the respective frequency, "A" or "B". With "CATCC CONT" selected, LSO communication is also through the CATTC radios but is automatically switched to the proper control frequency ("A" or "B") through CATCC (provided CATCC is not in the manual mode). In this automatic switching mode, a pushbutton frequency select switch on the LSO radio selector control box enables the LSO to communicate on the alternate frequency ("ALT") regardless of the frequency in use by CATCC. If the LSO is on the same frequency, "SAME" is indicated on the switch.

5.2.5.4.2 "Whiskey Radio." In the "WSC-3 1" and "WSC-3 2" positions of the barrel switches, radio communication is shifted from the CATCC radios (primary mode) to the WSC-3 radios (backup mode) located on the LSO Base Console. The WSC-3 radios have 20-channel selection of preset frequencies, with one channel normally set to 243.0 (UHF Guard) for emergency use. Both WSC-3 radios should not be selected to the same frequency simultaneously, as this may damage the UHF antenna coupler in the system. On the LSO barrel switches, selection of "WSC-3 1" provides radio communication for that particular LSO's handset on the frequency (channel) selected on WSC-3 #1; "WSC-3 2" position provides communication on the frequency (channel) selected on WSC-3 #2. Each WSC-3 control panel has a volume control which operates only for a handset which may be plugged into the receptacle on the faceplate of that WSC-3 radio. Normal volume control for the WSC radios is with the volume knob adjacent to the barrel switch on each radio selector control box.

5.2.5.4.3 LSO UHF Handsets. The LSO handsets utilize a noise reduction transmitter with a pushbutton control. An override function is available on one 7-pin handset (a red button) which allows the LSO to override transmissions ONLY when using CATCC radios. Most LSO platforms are equipped with at least 3 handsets, to have one for the controlling, backup, and CAG LSOs and, in some cases, an additional handset for an LSO trainee to monitor. Four receptacles for the UHF handsets are located beneath the HUD Console, two on each side (two 5-pin receptacles, two 7-pin receptacles). Two additional handset receptacles (5-pin) are located on the lower right side of the LSO Base Console.

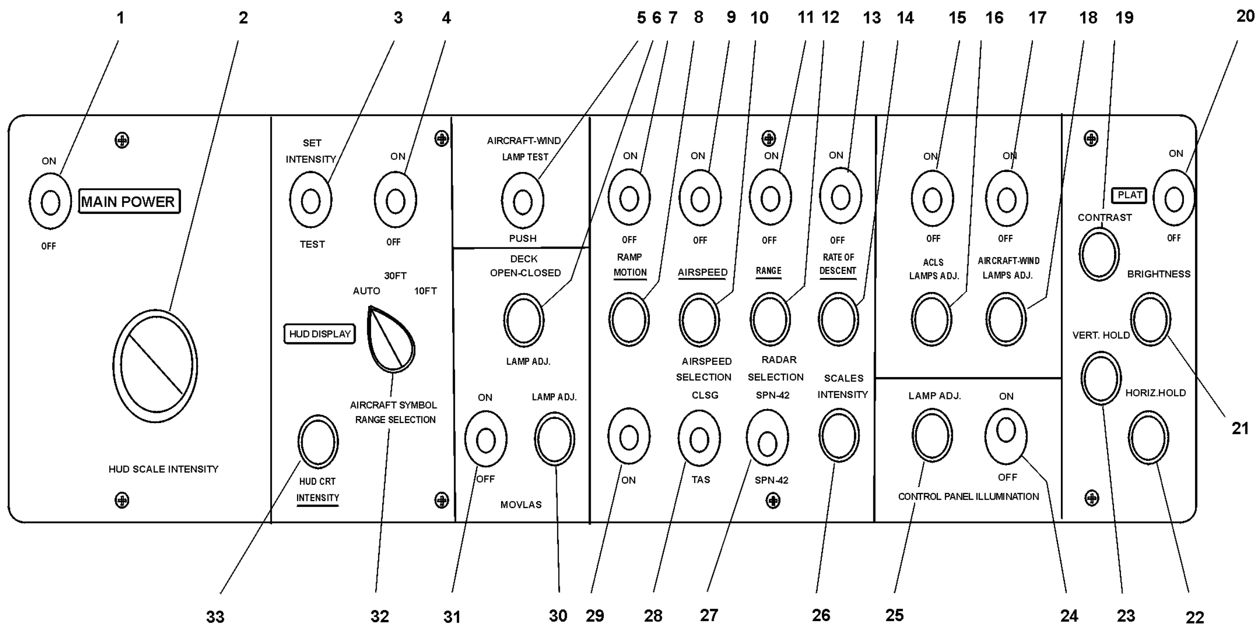


Figure 5-10 LSO HUD Console Control Panel, Controls and Indicators

LSO HUD Console Control Panel Controls and Indicators

Nomenclature	Index No.	Purpose
MAIN POWER Switch	1	Turns the console on or off, but only if the rear cover is in place.
CONTROL PANEL ILLUMINATION ON/OFF	24	ON/OFF switch for control panel backlighting.
CONTROL PANEL ILLUMINATION LAMP ADJ.	25	Controls brightness of control panel backlighting.
HUD DISPLAY, ON/OFF	4	Turns Heads-Up Display on or off, leaving appearance of the display under control of switch (3).
HUD DISPLAY, SET INTENSITY/NORMAL/TEST	3	Three-position toggle switch. When switch is held in the SET INTENSITY position, the Heads-Up Display (HUD) is activated. Adjust HUD SCALE INTENSITY (brightness), using control (2). Adjust HUD CRT INTENSITY (signal trace brightness), using control (33). When switch is released, it returns to NORMAL position and the HUD goes dark until an ACLS lock-on signal from the ship automatically turns it on. The TEST position activates the HUD, for checkout, when the ship ACLS signal is not present.
HUD SCALE INTENSITY	2	Controls Heads-Up Display reference scale brightness**.**
HUD DISPLAY, HUD CRT INTENSITY	33	Controls brightness of Heads-Up Display.
HUD DISPLAY, AIRCRAFT SYMBOL RANGE SELECTION	32	Three-position rotary switch; controls scale of HUD glideslope and line-up displays. In the AUTO position, a change of HUD scale occurs automatically as the approaching aircraft reaches 1.2 miles from touchdown. Beyond 1.2 miles, the HUD scale is 30 ft/div; at less than

		1.2 mile, the HUD scale is 10 ft/div. At 1.2 miles, the aircraft symbol - or "bug" - changes shape, as described below. In the 30 ft position, the HUD scale remains at 30 ft/div regardless of aircraft position. When this scale is in use, the aircraft symbol is a circle only. In the 10 ft position, the HUD scale remains at 10 ft/div regardless of aircraft position. When this scale is in use, the aircraft symbol is a circle with wings and tail added.
DECK OPEN- CLOSED LAMP ADJ.	6	Controls brightness of OPEN and CLOSED lamps of the Deck Status Indicator (14 Figure 5-9).
RAMP MOTION, ON/OFF	7	ON/OFF switch for the Ramp Motion Indicator lamps.
RAMP MOTION, adjust	8	Controls brightness of Ramp Motion Indicator lamps.
RAMP MOTION, TRIM/ON	29	In the TRIM (down) position, only the static trim data is displayed on the Ramp Motion Indicator and on the Heads-Up Display.
AIRSPEED, ON/OFF	9	ON/OFF switch for the Airspeed Indicator lamps.
AIRSPEED, Adjust	10	Controls brightness of airspeed indicator lamps.

AIRSPEED SELECTION CLSG/TAS	28	In the CLSG (up) position, the closing speed of the approaching aircraft is displayed; in the TAS (down) position, true airspeed is displayed.
RADAR SELECTION SPN-44/SPN-42	27	Airspeed data from the SPN-44 radar is displayed on the Airspeed Indicator when the toggle switch is in the SPN-44 (up) position; airspeed data from the SPN-42 radar is displayed when the switch is in the SPN-42 (down) position.
RANGE, ON/OFF	11	ON/OFF Switch for the Range Indicator lamps.
RANGE, adjust, R11	12	Controls brightness of Range Indicator lamps.
RATE OF DESCENT, ON/OFF	13	ON/OFF switch for the Rate of Descent lamps.
RATE OF DESCENT, adjust	14	Controls brightness of Rate of Descent Indicator lamps.
ACLS, ON/OFF	15	ON/OFF Switch for the Automatic Carrier Landing System (ACLS) Indicator lamps.
ACLS, LAMPS ADJ.	16	Controls brightness of ACLS Indicator lamps.
AIRCRAFT-WIND, LAMP TEST	5	Seven-segment lamps in ACLS Indicator Assy may be tested by pressing this switch
AIRCRAFT-WIND, ON/OFF	17	ON/OFF Switch for the aircraft type, wind speed, and direction indicator lamps
AIRCRAFT-WIND, LAMPS ADJ	18	Controls brightness of aircraft type, wind speed, and direction indicator lamps.
PLAT, ON/OFF	20	ON/OFF Switch for the Pilot Landing Aid Television (PLAT) Monitor.
PLAT, CONTRAST	19	Controls picture contrast of the PLAT Monitor.
PLAT, BRIGHTNESS	21	Controls picture brightness of the PLAT Monitor.
PLAT, HORIZ HOLD	22	Horizontal hold control for the PLAT Monitor.
PLAT, VERT. HOLD	23	Vertical hold control for the PLAT Monitor.
SCALES INTENSITY	26	Controls brightness of all scale lamps of the ramp motion, airspeed, range, and rate of descent indicators.

MOVLAS, ON/OFF Switch	31	ON/OFF switch for the Manually Operated Visual Landing Aid System (MOVLAS) display (13, Figure 5-9).
MOVLAS, LAMP ADJ.	30	Controls MOVLAS display lamp brightness.

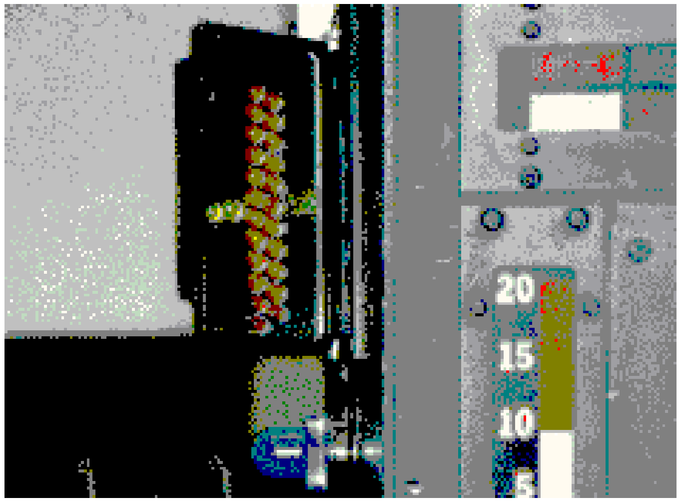


Figure 5-11 Heads-up Display (left side) Showing MOVLAS Repeater

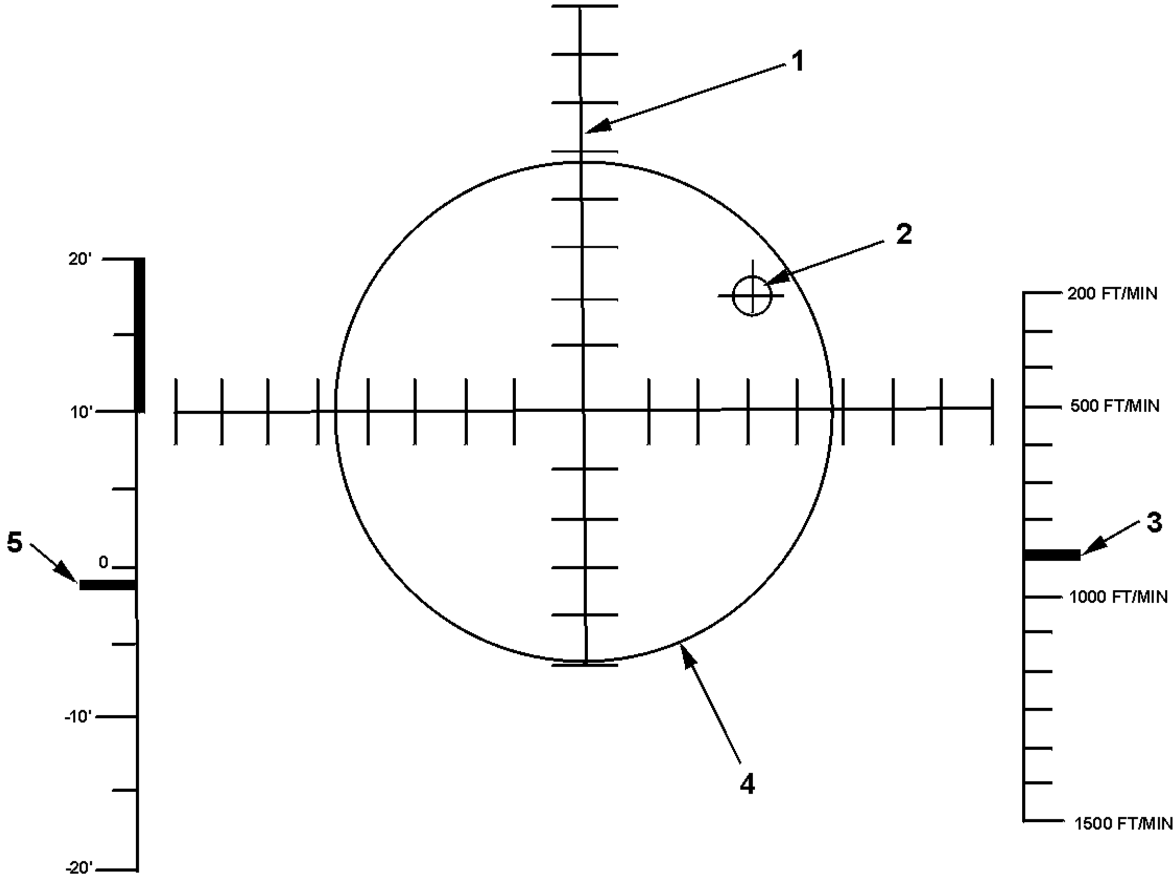


Figure 5-12 Heads-Up Display

Nomenclature	Index No.	Purpose
Reticle Image	1	A fixed image, to which is referenced electronically generated data.
Aircraft Symbol	2	Electronically generated symbol, shows aircraft Symbol location in relation to correct glideslope/lineup path. An ideal approach places aircraft symbol at intersection of vertical and horizontal reticle lines. Absence of wings and tail in the symbol indicates that the glideslope and lineup error scales are 30 ft/division. Presence of wings and tail indicates that the scales are 10 ft/division.
Rate-of-Descent Indicator	3	Electronically generated pointer; duplicates data presented on LSO HUD Console.
Range Circle	4	Electronically generated circle; complete circle appears when aircraft is one mile from flight deck; then circle disappears, in counterclockwise direction, with each 90° representing 1/4 mile of approach. Circle disappears completely at touchdown.
Ramp Motion Pointer	5	Electrically generated pointer; duplicates data presented on LSO HUD Console.

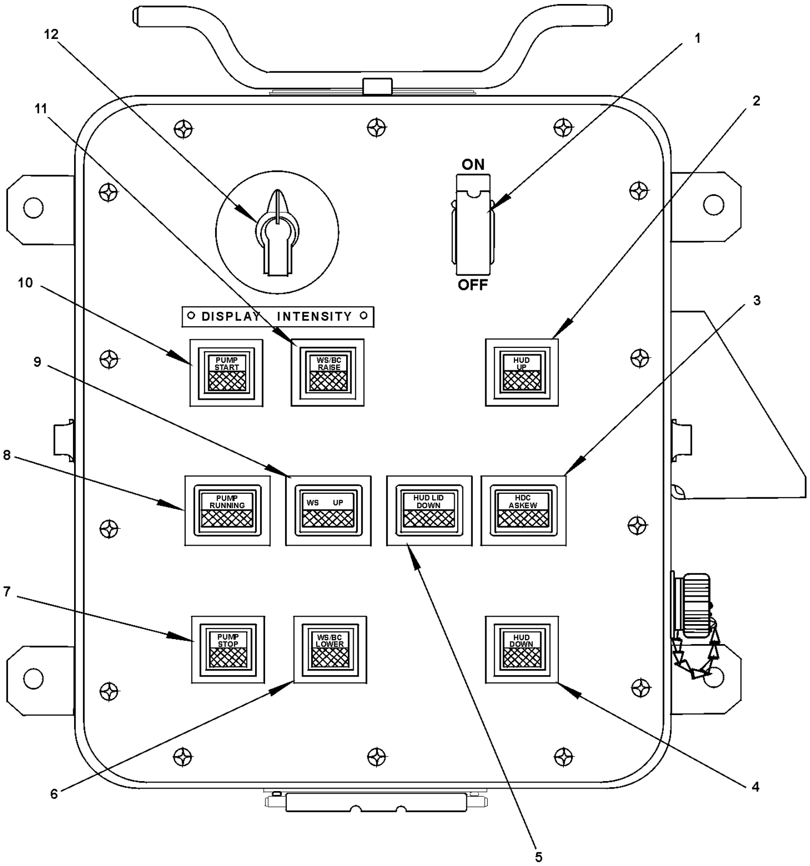


Figure 5-13 Hydraulic Lift Control Panel Assembly, Controls and Indicators

Hydraulic Lift Control Panel Assy
Controls and Indicators

Nomenclature	No.	Purpose
ON/OFF Switch	1	Actuates 115VAC power for lifting unit control unit.
HUD UP Switch	2	Initiates hydraulic cylinder action, raising the console out of its weather cover to desired operating height.
HUD ASKEW Indicator	3	Lights when console is not properly aligned to enter console weather cover.
HUD DOWN Switch	4	Lowers hydraulic cylinder and returns console to its weather cover.
HUD LID DOWN Indicator	5	Lights when the weather cover's hinged cover (lid) is fully down; goes out when lid is raised.
WS/BC LOWER Switch	6	Lowers windscreen and the Base Console.
PUMP STOP Switch	7	Stops hydraulic pump after console has reached desired operating height.
PUMP RUNNING Indicator	8	Lights when hydraulic pressure pump is running.
WS UP Indicator	9	Lights when windscreen is in operating position, fully vertical.
PUMP START Switch	10	Activates hydraulic pressure pump.
WS/BC RAISE Switch	11	Raises windscreen and the Base Console.
DISPLAY INTENSITY Control	12	Controls light level of switch and indicator lamps.

CHAPTER 6

CV(N) LIGHTING AND MARKINGS

6.1 GENERAL

In addition to the Fresnel Lens Optical Landing System (FLOLS), there are numerous other visual landing aids used to aid pilots in safe approaches to the carrier. A firm understanding of these aids and how they are controlled and where they are located can significantly help in easing pilot work load, especially during adverse weather conditions and moving deck situations. In nearly all cases, you as the LSO will be first to recognize these conditions since you are the only person exposed to the elements in direct control of aircraft. Therefore you must be knowledgeable of these aids so that you can ensure their proper use. This comes into play, in particular, with height obstruction limits when aircraft are parked port side aft of the lens.

6.2 STANDARDS

Visual landing aids are standardized to the maximum extent possible and are described in Visual Landing Aids General Service Bulletin No. 8 (latest revision) and modified by subsequent service changes and bulletins. This publication describes standard markings, lights, lighting controls, optical devices (including sections on FLOLS, MOVLAS, and PLAT), symbols, and other devices used for visual references for guidance of pilots, while operating aircraft aboard ship and in the air. It also contains drawings for specific locations on each carrier. The portions described below are directly applicable to the LSO business, but are only a part of that described in the bulletin.

6.3 RESPONSIBILITY

COMNAVAIRSYSCOM (Naval Air Systems Command) is responsible for providing a coordinated review of aviation facility designs submitted by activities of the COMNAVSEASYSCOM (Naval Sea Systems Command) and the COMNAVELEXSYSCOM (Naval Electronic Systems Command).

6.4 FLIGHT DECK MARKINGS *(Figure 6-1)*

1. Barricade Stanchion **-** The entire stanchion is painted white with a six inch red and yellow striped border.

2. Starboard Safe Parking Line (Foul Deck) **-** Is an alternating red and white line located 50 feet starboard of the landing area centerline except at the starboard deck sheaves area where it runs outboard of the sheaves. This is the line that the Arresting Gear Officer uses to give you the final clear deck.

3. Port Safe Parking Lines (Foul Deck) - Inboard and outboard, establish safe parameters for port side aircraft parking. Parking outboard of the **inboard** line is restricted to height limitations and distances aft of lens. *(Figure 6-2.)* Parking outboard of outboard line is unrestricted. These lines provide unrestricted pilot view of the lens once the aircraft is on centerline but may preclude pilot acquisition of the ball from the 90 degree position to the groove with aircraft spotted port side.

CAUTION

Both port side foul deck lines are established with steady deck conditions. During moderate to severe moving deck conditions, or with certain ship's static mistrim conditions, pilots may lose sight of the entire lens with aircraft spotted port side. (Figure 6-3). Both the Air Boss and Aircraft handler need to be knowledgeable of this fact and be kept informed during moving deck conditions.

6.5 CV(N) FLIGHT DECK LIGHTING (Figure 6-4 & 6-5)

1. Deck-edge lights are spaced around the perimeter of the flight deck at approximately 40 foot intervals and provide low-intensity, blue, omni-directional illumination. These lights may be either globe type or semi-flush deck. Controls located in Pri-Fly and Flight Deck Lighting Control Stations provide dimming capability from blackout to full brightness. All deck-edge lights are shielded from view outboard.

2. Runway Centerline Lights are low profile, white, unidirectional lights using 100 watt quartz lamps, which, unlike incandescent bulbs, provide intense white light. They are located on the centerline of the runway area at intervals of 45 feet. Runway Athwart ship Lights are installed at the extremities of the landing area and are perpendicular to the runway centerline. They are spaced at 5-foot intervals with the same number of lights on each side of the runway centerline. They are similar in design to the centerline lights. Controls in Pri-Fly and the Flight Deck Lighting Control Stations may vary the light intensity from blackout to full brightness.

3. Most CV(N)s have incorporated a sequence flashing light control system to the centerline lights. This system provides the electronic circuitry for flashing the runway centerline lights in sequence from the ramp to the runway bow. The system increases lineup information for the pilot. Three modes of operation exist:

a. Light intensity control utilizing existing dimmer equipment.

b. Light intensity control without flashing utilizing solid-state circuitry of sequence flasher.

c. Light intensity control with flashing utilizing solid-state circuitry of sequence flasher. The system is capable of operating a maximum of 20 centerline lights with a time interval between flashing cycles of 0.2 to 2 seconds. Apparent speed of the flashing effect may be varied from 100 to 600 knots. The flash intensity and background intensity may also be varied.

4. Approximately 9 to 14 Vertical Dropline Lights, containing red lamps, are arranged in a vertical row below the ramp, perpendicular to the centerline of the runway.An additional lamp may be added to the circuit to afford visibility from the Pri-Fly control station. The lights are rated at 18 watts and have a nominal beam spread of 50 degrees in azimuth and 25 degrees in elevation. The center of the light beam is directed four degrees in elevation. These lights provide the primary visual aid to the pilot for aircraft lineup an can be used as a lineup aid from about 3 to 4 DME on in. Aircraft deviation from center line will show up as an apparent arrow to the pilot, indicating the direction he needs to fly to regain the centerline. Pilot caution should be used when making lineup corrections during moderate to heavy rolling deck conditions as this cue may be erroneous. Controls located in Pri-Fly and Flight Deck Lighting Control Station provide dimming capability from blackout to full brightness.

5. The Runway Edge Lights are located in rows parallel to, and 35 feet from, the runway centerline thus giving a total runway width of 70 feet. These lights are of low profile design and each contain a 45-watt quartz lamp, and a clear lens. Controls located in Pri-Fly and Flight Deck Lighting Control Station provide dimming capability from blackout to full brightness.

6. Axial Deck Bow Athwart ship Lights are installed across the axial bow facing aft on a line perpendicular to the ship's centerline. They are similar in design to the Runway Edge Lights.

7. The Safe Parking Line Lights are spaced approximately 45 feet apart and are located along the starboard safe parking line. They are of low profile design, and each contains a 45-watt quartz lamp with a red lens.

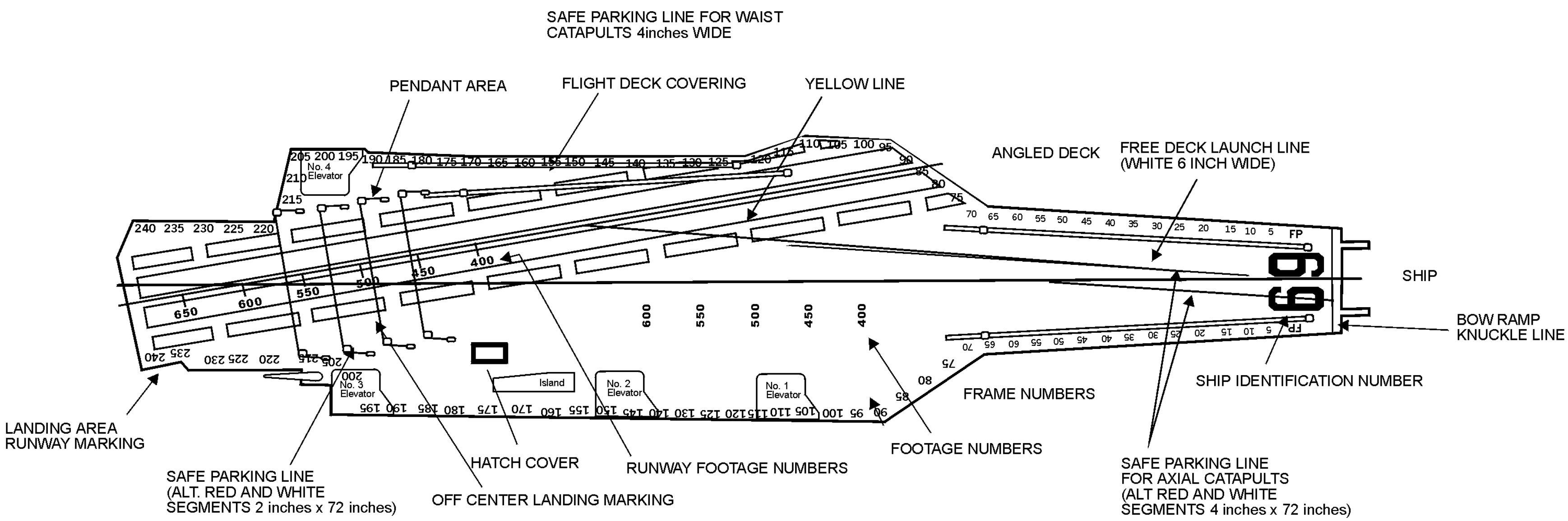


Figure 6-1 Flight Deck Markings and Lighting

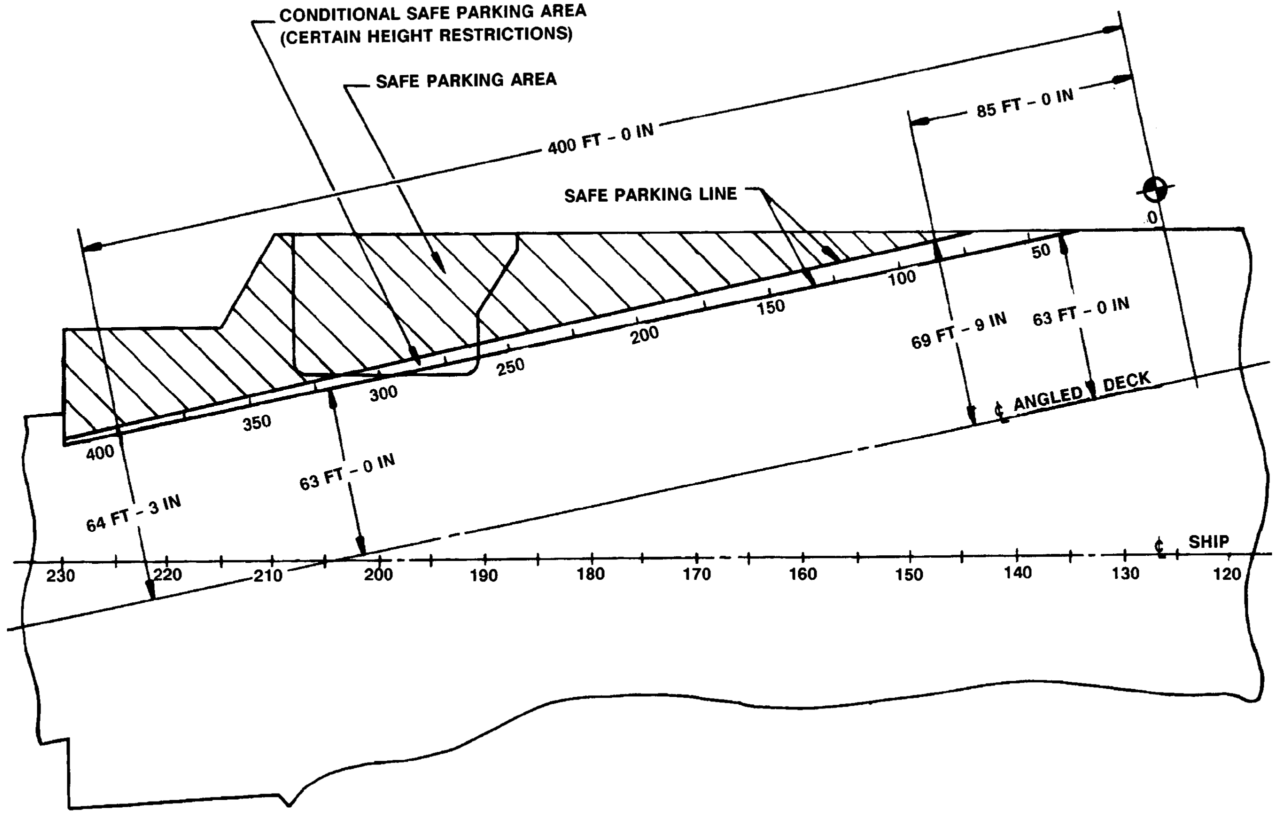


Figure 6-2 Portside Safe Parking Line Markings (CV-63 and CV-64)

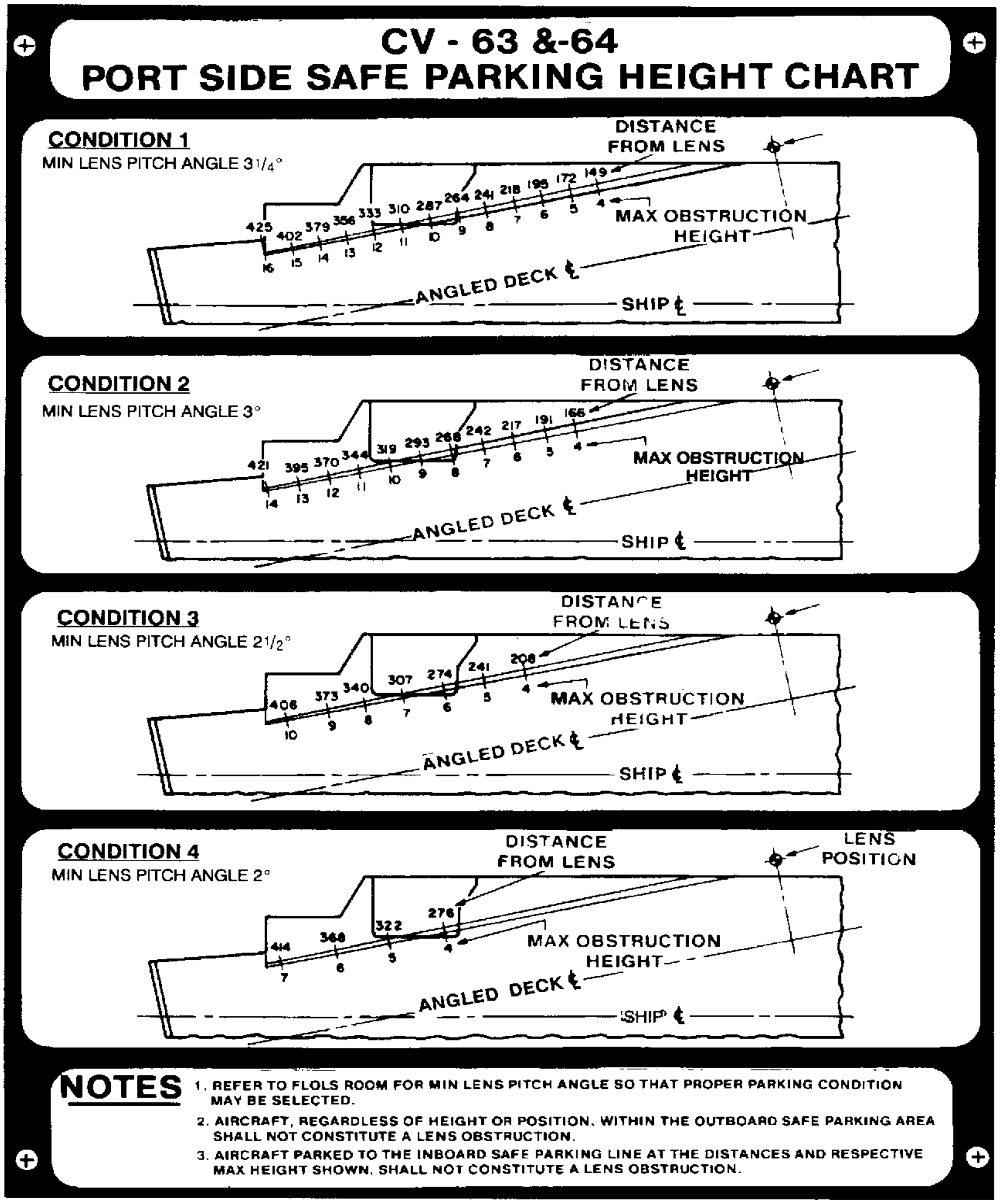


Figure 6-3 Portside Parking Height Chart (CV-63 and CV-64)

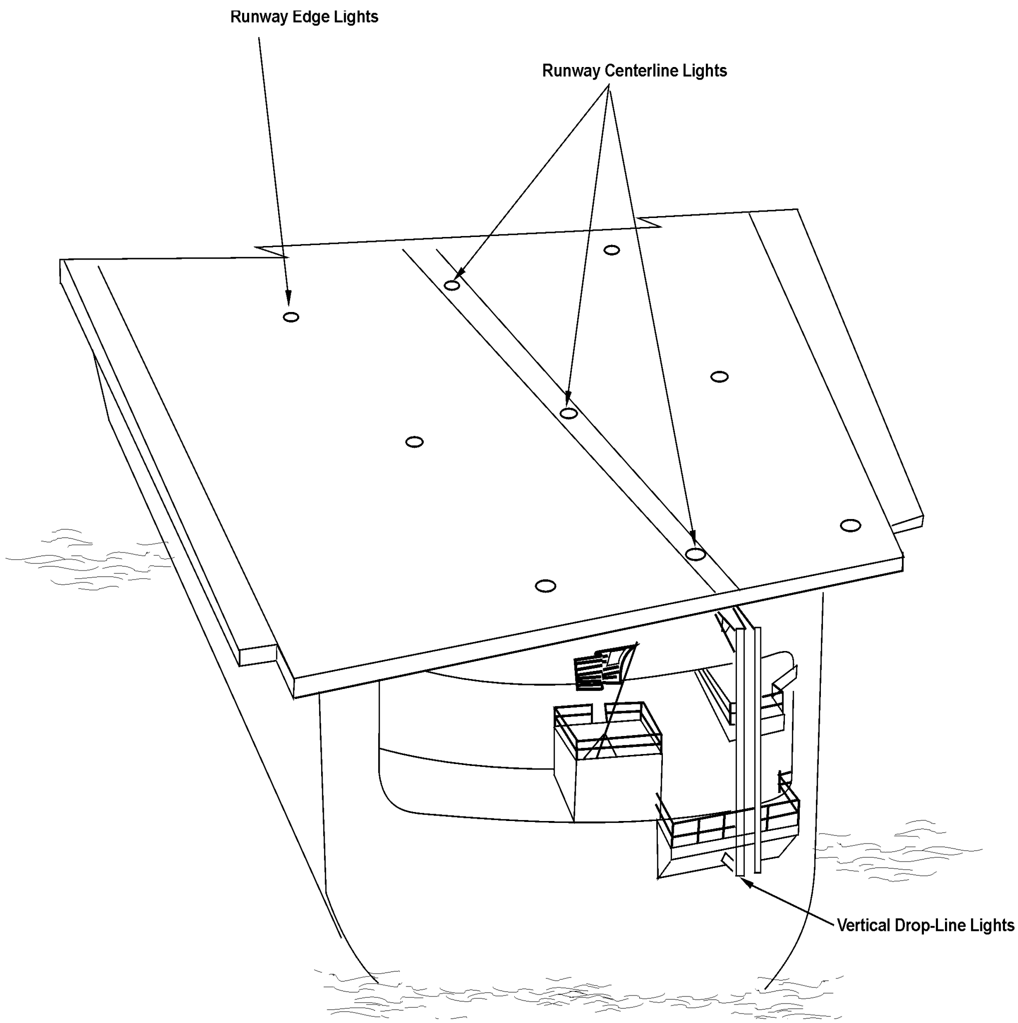


Figure 6-4 CV Standard Vertical Dropline Arrangement

8. Overhead Yellow Floodlights are installed to provide adequate yellow light illumination of the flight deck for support of night operations. The lights are mounted on the ends and inboard side of the island structure. Suitable foundations, platforms, ladders and railings facilitate servicing and cleaning. The floodlight is equipped with a red filter and hood which limits the emission of stray light. Each light fixture may be equipped with a narrow beam or medium beam 300-watt lamp selected to provide the desired coverage. There are four groups of lights about 60 feet above the deck and are grouped in four circuits for illumination of the axial deck bow, and the landing area forward, midships and aft. Controls located in Pri-Fly and Flight Deck Lighting Control Stations provide dimming capability from blackout to full brightness.

9. Overhead White Floodlights are mounted on the inboard island structure at the 0-9, 0-10, and 0-11 levels. These lights are provided with 1000 watt lamps. Dimmer controls are located in Pri-Fly only and provide dimming capability from blackout to full brightness.

10. Four banks of Low Pressure Sodium (LPS) Floodlights (banks consisting of 180 watt, 135 watt, 90 watt, and 55 watt fixtures) are located on the 08, 09, 010, or 011 levels of the island structure to provide flight deck illumination. These lights are aimed to provide coverage of the axial bow, and landing area forward, midships, and aft. Each light is capable of being switched on/off (no dimming capability) individually from Pri-Fly only. Flight deck illumination may be controlled by the Air Officer in each area by energizing various combinations of LPS floodlights. LPS floodlights require a warmup period which must be considered when varying combinations of energized floodlights.

11. Catapult Hook-Up Illumination Lights are located, in pairs, approximately five feet forward of and to either side of each catapult shuttle. The lights are shielded to produce a low profile red beam of light aimed at the aircraft launch bar and catapult shuttle.

12. The Rotating Beacon Signal System employs three sets of rotating beacons. They are installed on the island structure and located as to be seen readily from the forward catapult area, the waist catapult area, and the runway landing area. Each set contains three rotating beacons; red, amber, and green. Each beacon contains four 50-watts lamps with appropriate colored filters mounted on a rotating slip ring assembly. When the beacon is operated, two lamps, 180 degrees opposite each other, are energized and the other two lamps are off. The beacon rotates at 30 RPM, and produces 60 flashes per minute. The four lamps are wired into a transfer switch with two circuits so that either pair of lamps may be selected providing 100% backup in the event of a lamp failure.

The rotating beacon system is controlled from Pri-Fly. The red beacon signifies a closed deck for launch or recovery (as applicable); green indicates an open deck; amber indicates engagement or disengagement of helicopter rotors is in progress. In addition to indicating status information, beacons may also be used to provide time-to-launch information to flight deck personnel. Specific signals may vary. See the Air Department SOP (CNAL / CNAPINST 3100.4 series) and Aircraft Launch and Recovery Operations Manual (CNALINST 13800.3/CNAPINST 13800.9 series) for a more detailed discussion of rotating beacon use.

13. The HERO Condition III rotating beacon is identical to the other beacons except that it has a blue filter installed. It is used to signal flight deck personnel when HERO Condition III is set.

14. The Landing Area Status Light System consists primarily of two light assemblies containing red and green lights. These light assemblies are located on the port side aft of the LSO platform, with one light assembly being visible to the LSO and Pri-Fly, and the other light assembly visible to the Arresting Gear Officer. Two sets of lamps are used in each assembly (one set is a backup or for night use, may have lower wattage lamps). Colored roundel lenses are used to create the red (foul deck) and green (clear deck) lights. The red roundels are installed on the left side (as viewed from the front of each assembly), the green installed on the right.

The control circuit for the status lights is routed through the aft (landing area) rotary beacon system, retractable sheaves, waist catapult bubble (CVN-68 and subsequent CVs), and Arresting Gear Officer's dead-man pickle switch. Before the green lights can be activated by the Arresting Gear Officer depressing his pickle switch, the following conditions must be met:

1. Aft green rotating beacon must be activated.

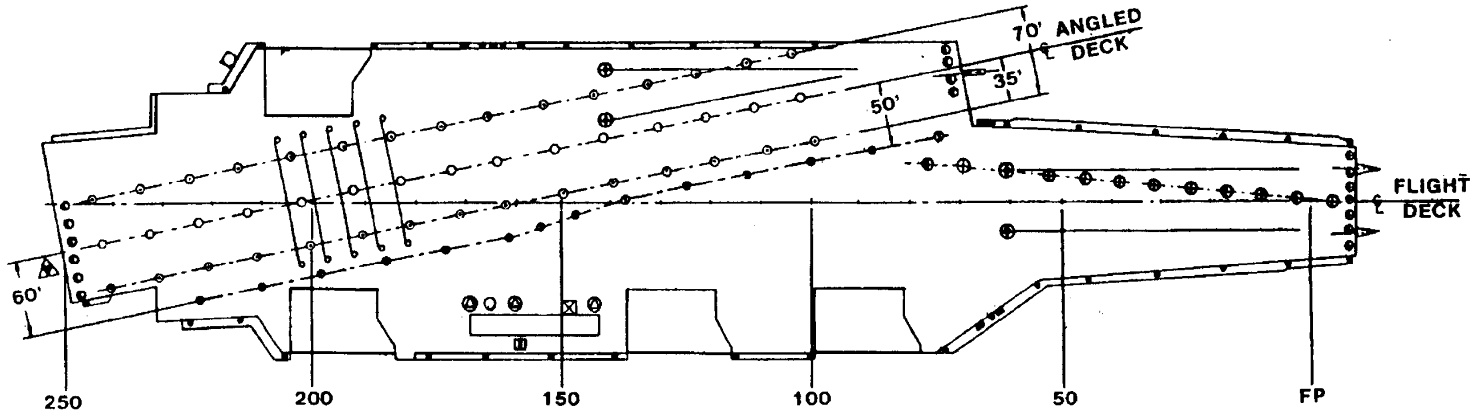
2. All retractable sheaves must be raised to the full-up position, or inoperative sheaves bypassed.

3. The Waist Catapult ICCS (Bubble)must be fully lowered (CVN-68 and subsequent).

The on/off switch and dimmer control are located at the LSO platform on the Base Console; the pickle switch is located at the Arresting Gear Officer's station.

In the event of a Landing Area Status Light System Failure, two methods of signaling clear/foul deck status are used: red and green flags (or paddles) during daytime operations, or red and green signal wands at night. The Arresting Gear Officer will indicate deck status with his red or green flag/wand to the LSO platform phone talker, who will repeat the signal with the appropriate flag/wand in clear view of the LSOs (backed up with a verbal call).

In the event that a retractable sheave cannot be raised, a bypass switch may be used to bypass the circuitry for that engine; however, under no circumstances can aircraft be arrested on an engine with the retractable sheaves lowered. If a retractable sheave is to be left lowered, the crossdeck pendant must be removed.



LIST OF SYMBOLS

SYM	NOMENCLATURE	COLOR	ELEC SYM NO.	PART NO.	QUAN
●	DECK EDGE LIGHT	RED	239.1	NAEC 608303-1	37
◬	DROPLINE LIGHT	RED	243	NAEC 611831-1	11
○	CENTERLINE LIGHT	WHITE	253.1	NAEC 611403-1	15
◉	RUNWAY EDGE LIGHT	WHITE	260.1	NAEC 508447-1	30
◐	RUNWAY ATHWARTSHIP LIGHT (AFT)	WHITE	260.1	NAEC 508447-1	6
◐	RUNWAY ATHWARTSHIP LIGHT (FWD)	WHITE	260.1	NAEC 508447-1	4
⦶	HOMING BEACON	WHITE	258	BYLE P-400268	1
⊠	OVERHEAD FLOODLIGHT	WHITE	248.1	NAEC 612963-2	8
⊠	OVERHEAD FLOODLIGHT	WHITE	248	NAEC 612963-1	4
⊠	OVERHEAD FLOODLIGHT	WHITE	248.3	NAEC 612886-1	14
▥	OVERHEAD FLOODLIGHT	RED	263	NAEC 506829-1	38
⊕	CATAPULT HOOK-UP LIGHT	RED		NAEC 510538-1	36
⊕	CATAPULT HOOK-UP LIGHT	RED	260.1	NAEC 508447-2	40
⦶	FREE DK. LAUNCH LINE LIGHT	WHITE	260.1	NAEC 508447-1	12
⊗	ROTATING BEACON			FED. SIGN & SIG-	3
				NAL CO. NO. 8340F1	
⌶	SAFE PARKING GUIDE LIGHT	RED	250	NAEC 608304-1	14
⊖	BOW ATHWARTSHIP GUIDE LIGHT	WHITE	260.1	NAEC 508447-1	7
◘	LANDING AREA STATUS LIGHT	RED/GRN		NAEC 610647-1	1
	SEQUENCE FLASHING SYSTEM			NAEC 507625-1	1
▬	DECK MOUNTED FLOODLIGHT		247.3	NAEC 609331-1	6

Figure 6-5 Flight Deck Lighting Arrangement (CVN-70 shown)

CHAPTER 7

ELECTRONIC LANDING AIDS

7.1 GENERAL

There are two operational types of electronic approach aids available in the Fleet. These are commonly referred to as the ICLS (Instrument Carrier Landing System) and the PALS (Precision Approach and Landing System).

7.2 ICLS

7.2.1 Purpose. The ICLS provides the pilot with precise and continues independent source of glide path and centerline data error and enabling the pilot to fly the aircraft to appropriate minimums. This increases the pilot's confidence in the PALS flight control system. The ICLS also provides a secondary source of glide path and centerline data to the pilot in case of failure in any portion of the PALS system.

7.2.2 Components. The system consists of the aircraft installed receiving/decoding set AN/ARA-63, the shipboard transmitting set AN/SPN-41, or the shorebased transmitting set AN/TRN-28. The ICLS does not have a display on the LSO console. The status of the ICLS is displayed on either the AN/SPN-41 control panel located in CATCC or the AN/TRN-28 control panel located in Radar Air Traffic Control Facility ashore.

7.2.2.1 AN/ARA-63. The AN/ARA-63 is the airborne approach system which receives and decodes the pulse coded signals from the AN/SPN-41 or AN/TRN-28 and displays the deviation commands in the cockpit. With the AN/ARA-63 set on the proper channel, approach guidance can be received over 50 miles in clear weather and 10 miles in 10mm/hr of rainfall from the ship or shore station when the aircraft is within the ICLS scan pattern. The AN/ ARA-63 displays the total coverage area in two zones; the full deflection zone, and the proportional deflection zone. The proportional deflection area for elevation is $\pm$1.4° about the glideslope and for azimuth $\pm$6° about the centerline. The full deflection area covers the remaining portion of the coverage area. The AN/ARA-63 may be set to any of 20 channels in the 15.4 to 15.7 gigahertz frequency range.

Since the SPN-41 and the TRN-28 landing aid systems simply radiate a beam into space, there is no allowance made for the aircraft heading. *(See Figures 7-1 and 7-2.)* When an aircraft is left of centerline the flight director indicates fly right. If an aircraft approaches the final bearing from the left, such as on an arc, the flight director will indicate fly right. This must not be misinterpreted to mean to fly right to intercept the final bearing. The pilot must know the relative position of the ship to preclude this from happening.

Since glideslope information is usually available in marshall, pilots may decide to fly it rather than descend to the normal 1200 feet MSL pattern. Since this will change the relative closure rates between aircraft, all pilots must comply with the published CV NATOPS and Air Wing approach procedures.

The elevation flight director information must not be flown at greater than $\pm$20° off the centerline because accuracy is significantly degraded outside this angle.

7.2.2.2 AN/SPN-41. The AN/SPN-41 system utilizes scanning beam microwave antennas which transmit Ku-band (15.4 to 15.7 GHz) surface-to-air signals. Separate antenna units are used to transmit the elevation and azimuth information. *(See Figure 7-3)* Glideslope and azimuth information is generated by scanning narrow fan-shaped beams across the coverage areas. The azimuth coverage is $\pm$20° on either side of the centerline and the elevation coverage area is from the horizon to 20°. The azimuth transmission unit is stabilized for ship's motion in the roll and yaw axes and the elevation transmitting unit is stabilized in the pitch and roll axis. The azimuth transmitting unit is located at the aft end of the carrier on centerline sometimes replacing several drop lights. The elevation transmitter unit is located either on the port side approximately 125 feet aft of the lens or on the starboard side aft of the island.

DIMENSIONS OF PROPORTIONAL AREAS AND CENTERLINE/GLIDE SLOPE BEAMS

1.25 NAUTICAL MILES TO TOUCHDOWN

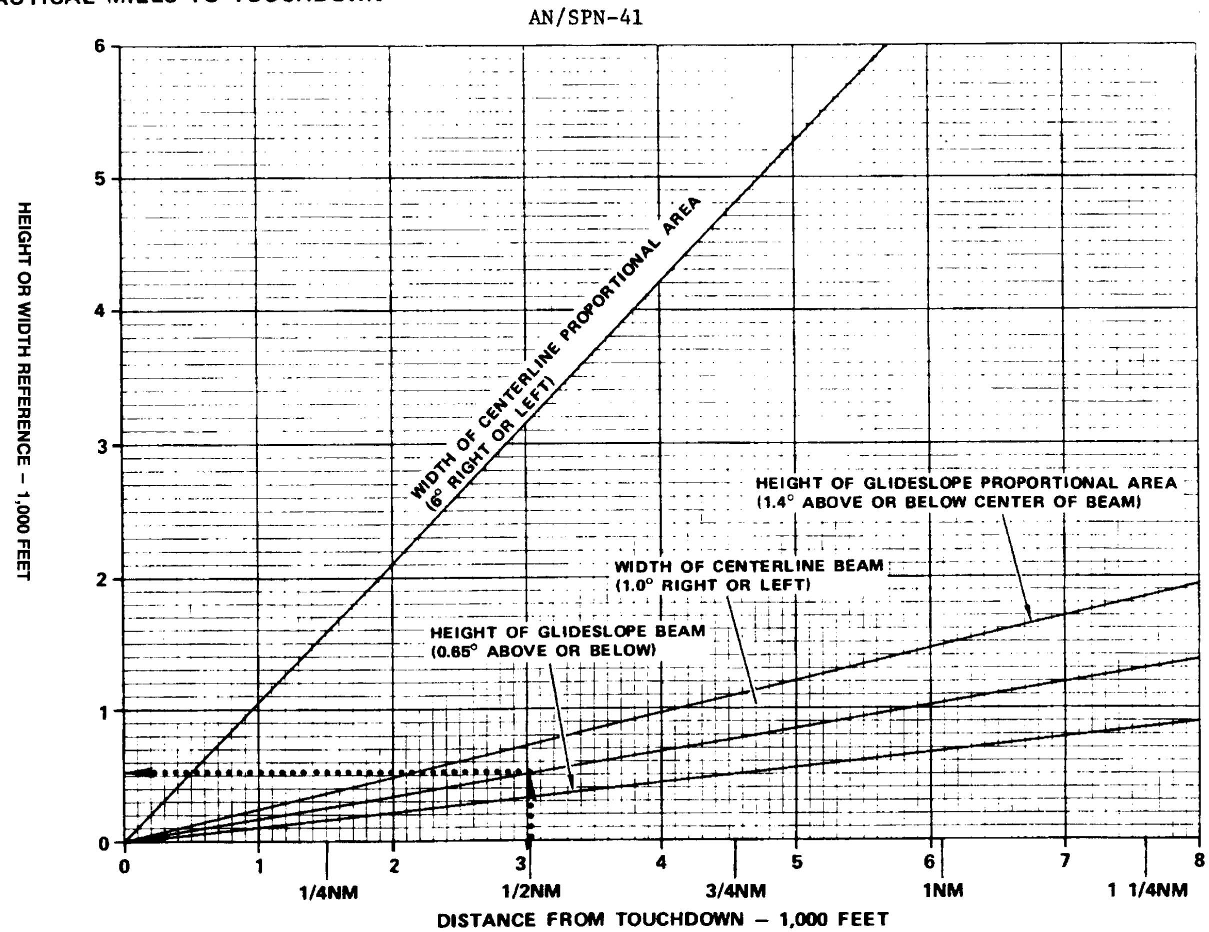


Figure 7-1 Dimensions of Proportional Areas and Centerline/Glideslope

DIMENSIONS OF PROPORTIONAL AREAS AND CENTERLINE/GLIDESLOPE BEAMS

5 NAUTICAL MILES TO TOUCHDOWN

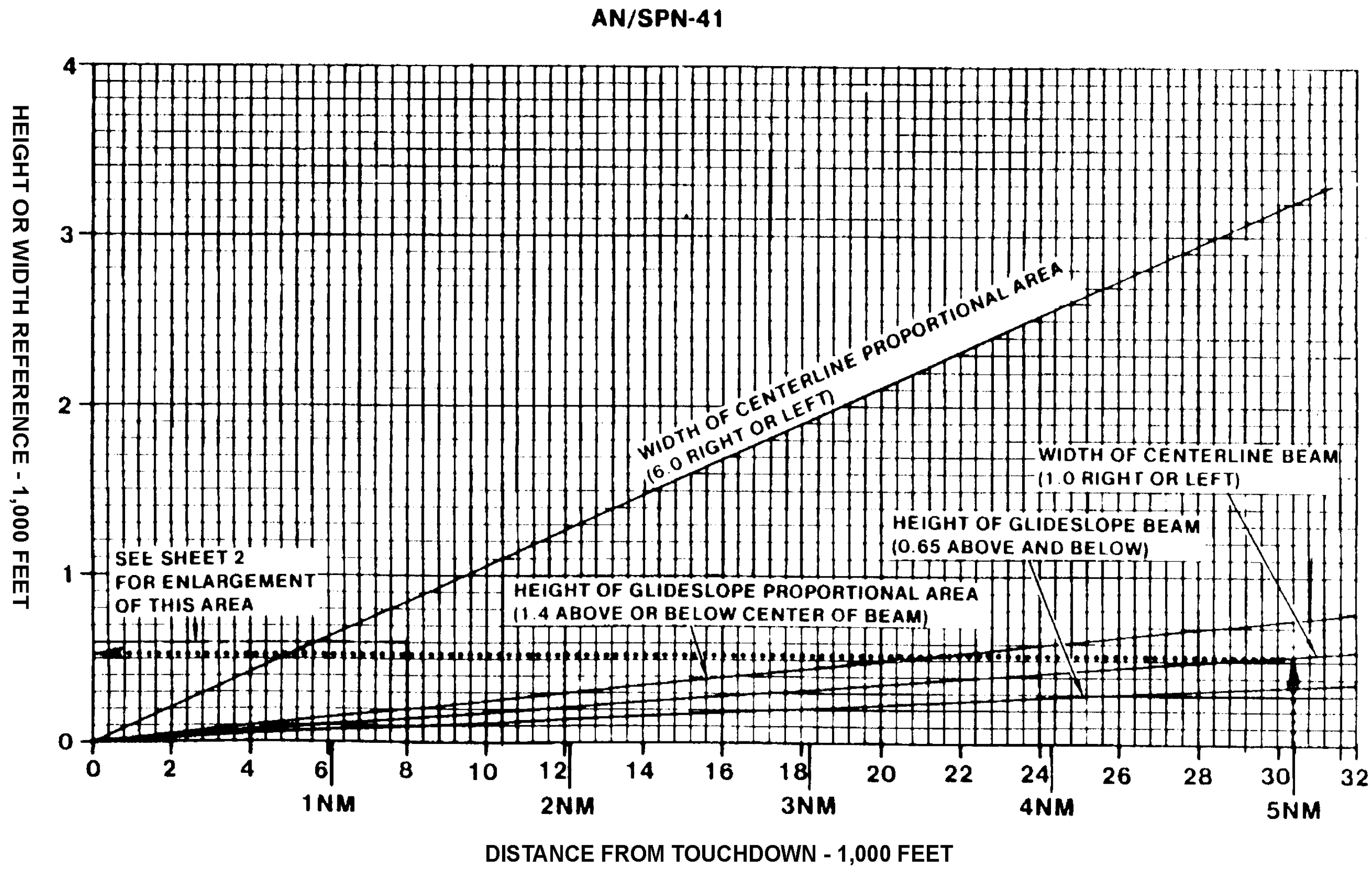


Figure 7-2 Dimensions of Proportional Areas and Centerline/Glideslope

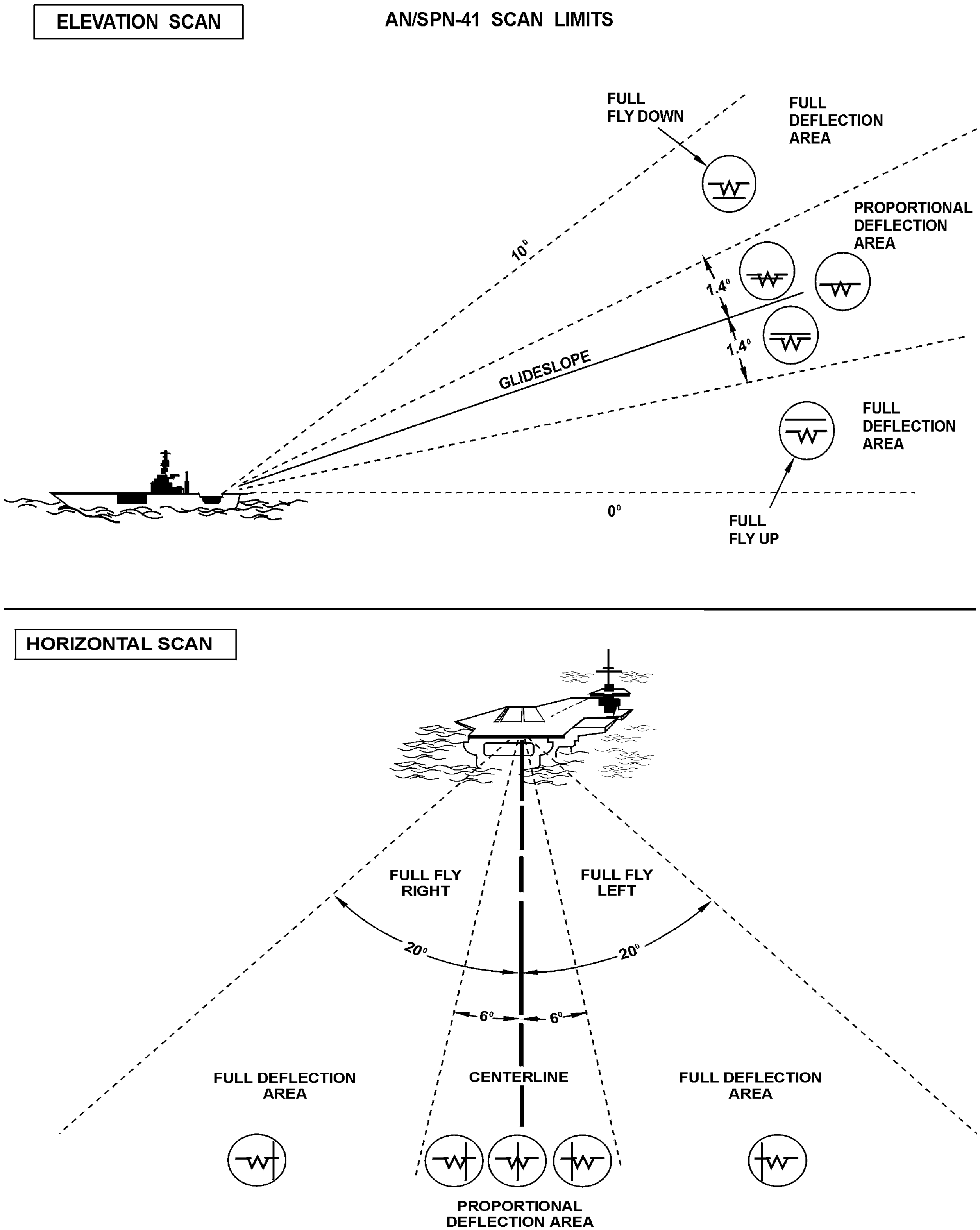


Figure 7-3 AN/SPN-41 Scan Limits

NOTE

Due to the offset installation of the transmitter, elevation data becomes increasingly inaccurate as the aircraft approaches the ship and should not be used inside 1/4 mile.

7.2.2.3 AN/TRN-28. The AN/TRN-28 is the shore based model which operates in a similar fashion to the AN/SPN-41. The azimuth antenna is located 1000 feet past the far end of the runway and the elevation unit is located so as to properly align its glideslope with the Fresnel Lens glideslope. The AN/TRN-28 is installed at NAS Oceana, Cecil, Miramar, Lemoore, Whidbey Island, and NALF San Clemente.

7.3 PALS

The PALS shipboard equipment block diagram is shown in *Figure 7-4*. A block diagram of a typical suite of airborne PALS equipment is shown in *Figure 7-5.*

7.3.1 AN/SPN-46A. The AN/SPN-46A is designed to provide control of an aircraft during the final approach and landing sequence. It consists of two operating channels (Final A and Final B), each capable of controlling the approach and landing sequence of a returning aircraft to touchdown on the carrier flight deck. Operating in conjunction with other components of the shipboard automatic carrier landing system, each channel is capable of landing one suitably equipped aircraft a minute, providing a system landing rate of two per minute. Each channel has five modes of operation.

(1) Mode I - Fully Automatic to touchdown.

(2) Mode IA - Fully automatic to minimums of 200 feet and one-half mile.

(3) Mode II - semi automatic (manual approach using either SPN-41 or SPN-42 providing glideslope and lineup information to aircraft.

(4) Mode IIT - same as Mode II except uses CCA controller information as well.

(5) Mode III - talk down (manual approach using only CCA controller supplied information).

7.3.2 Approach Modes. PALS approaches using Modes IA, IIT, and III are the same as manual approaches in that the pilot is controlling the aircraft inside one-half mile. A Mode I approach is much different in that the shipboard computer is now controlling the aircraft's heading and altitude and an airborne computer is controlling the aircraft's power setting.

7.3.3 Acquisition Window. The acquisition window, generated as a function of automatic search, is centered on the approach path. Range of the acquisition window is established in accordance with the aircraft's closure rate to the carrier so as to allow sufficient time for control to meet touchdown dispersion and landing rate requirements. Window size is a function of range and search angles. Vertical size of the acquisition window at a nominal range of four nautical miles is 700 feet; horizontal size is 10,000 feet. Since this window is normally centered at 1200 feet MSL, the pilot should inform the controller if the aircraft will not enter the window at the normal attitude.

Azimuth scan limits are 25 degrees starboard to 75 degrees port of centerline, which allows for lockup of aircraft in the crosswind turn in the bolter pattern. Automatic acquisition occurs within a 30 second time frame as the aircraft approaches the window. *(See Figure 7-6)*.

Operating in the automatic mode under negligible conditions of ships motion, the system will land aircraft with a standard deviation of not more than 10 feet laterally and 20 feet longitudinally of the set touchdown point. Longitudinal dispersion with extreme ship motion may be degraded to 40 feet longitudinally. The absolute touchdown dispersion limits, however, will not exceed the safe landing area of the flight deck without a waveoff command being generated. The system can operate Mode I approaches with normal dispersion at touchdown under conditions of up to 30 knots forward speed, 1.25 degrees pitch, 5 degrees roll, 4 feet heave, and ship's course changes up to 1/4 degree per second. The system will operate outside these limits with a corresponding increase in touchdown dispersion or waveoff probability.

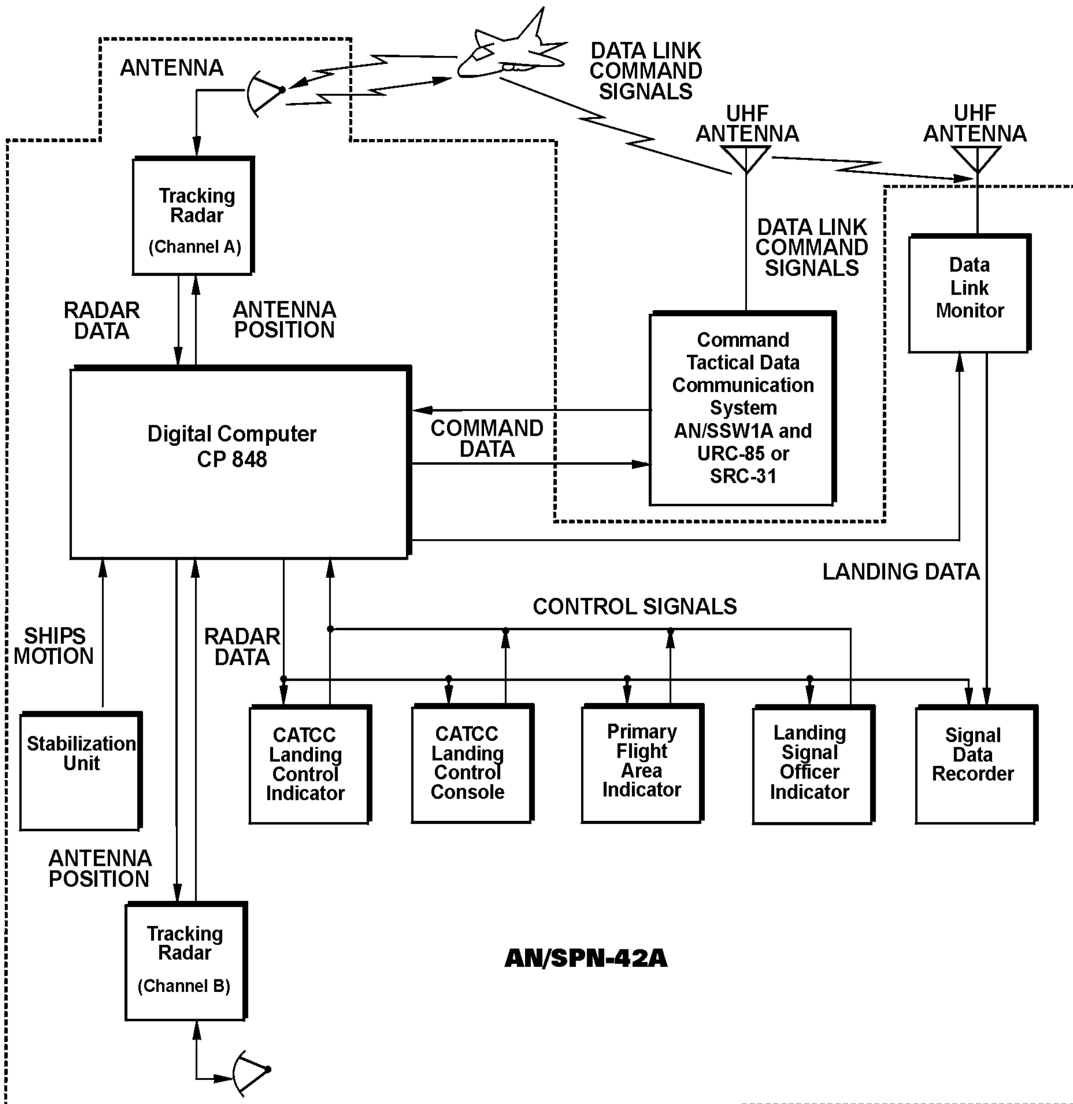


Figure 7-4 PALS Shipboard Equipment Block Diagram

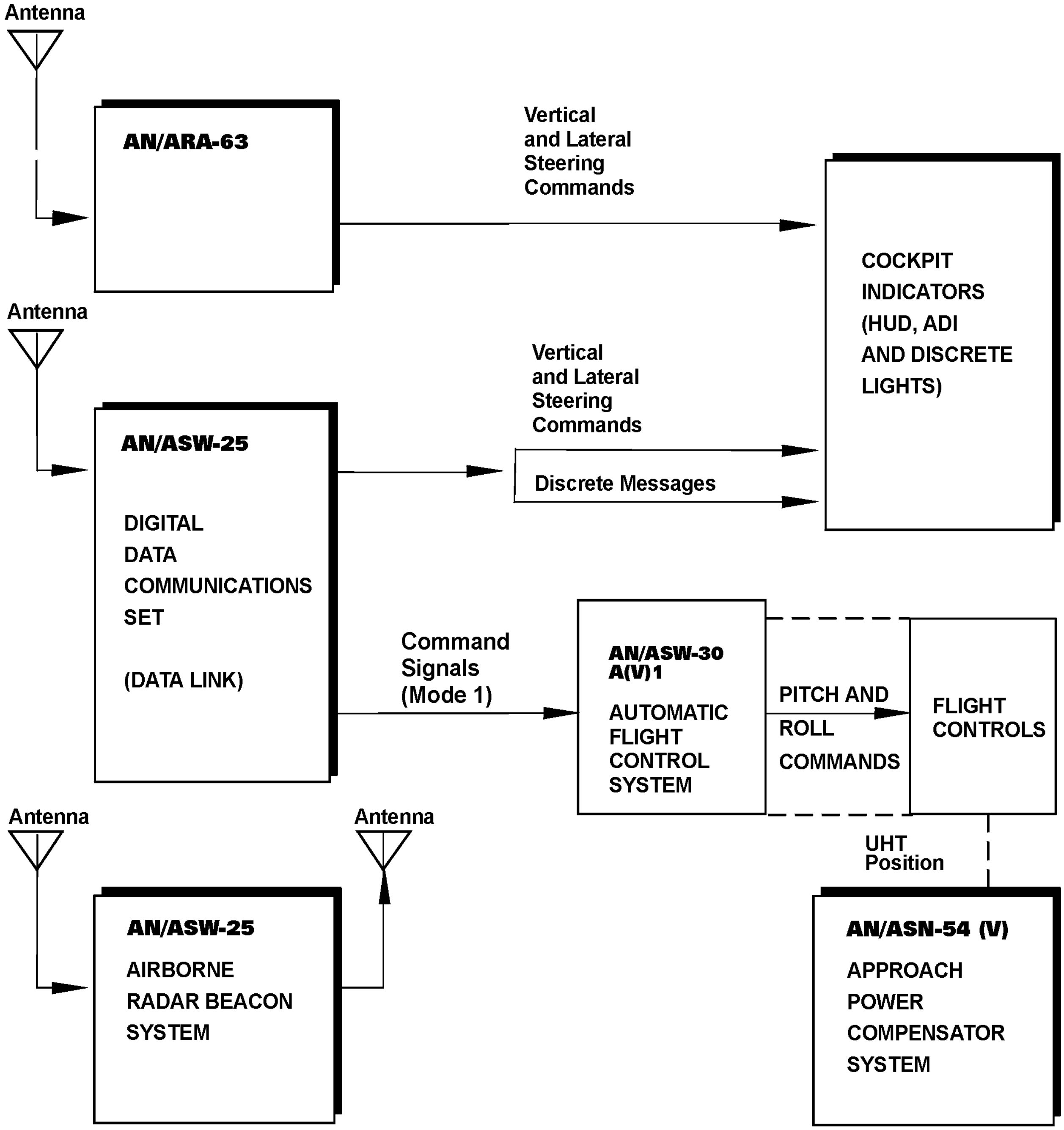


Figure 7-5 PALS Aircraft Equipment Block Diagram

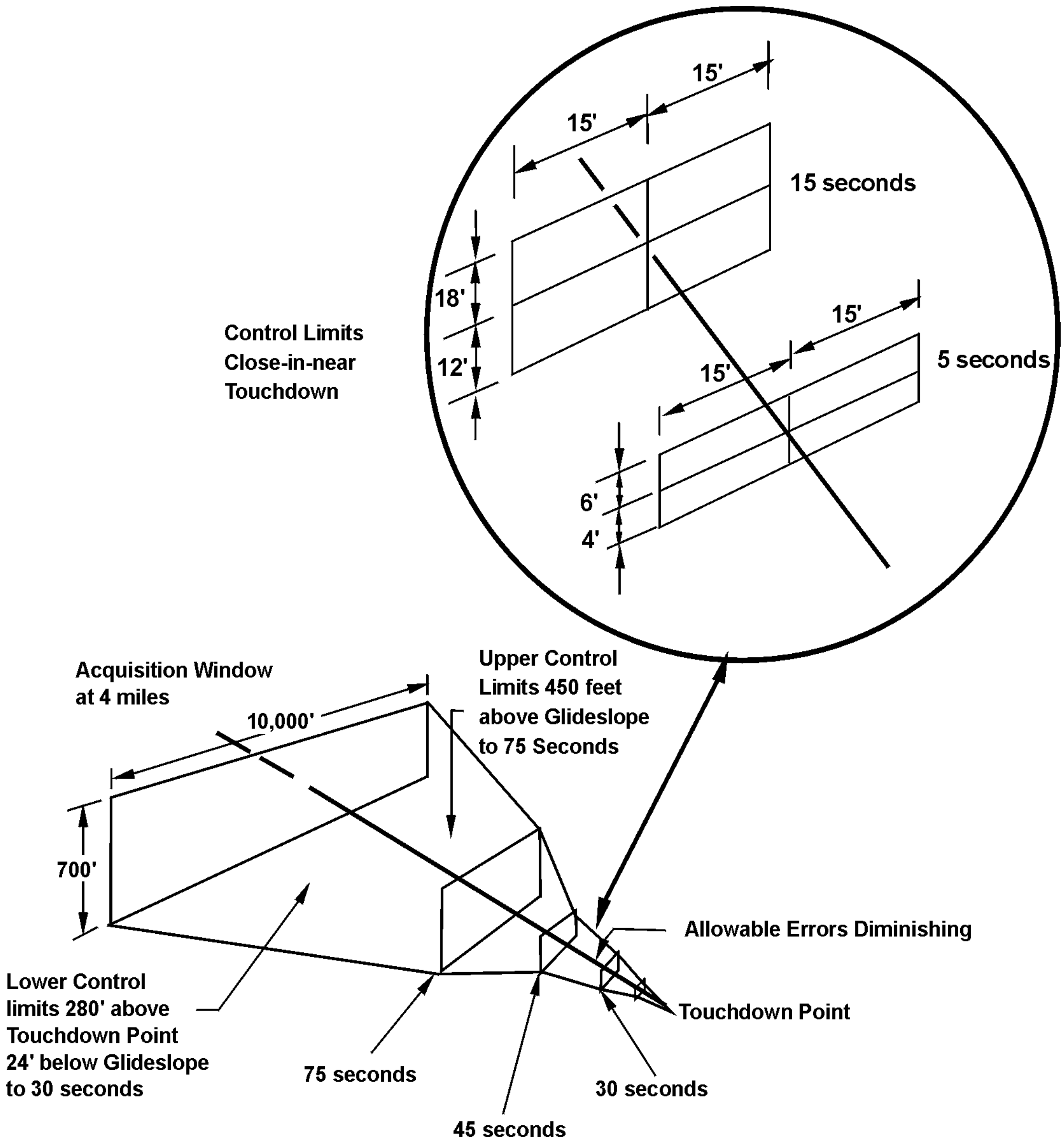


Figure 7-6 Pals Windows

7.3.4 System Elements. During PALS Mode I approaches, the AN/SPN-46A operates as a closed-loop system which exercises positive control of the aircraft from acquisition (normally 4 to 6 nautical miles) to touchdown. Major elements of the system are a precision tracking radar, stable platform, and general purpose computer. The system delivers flight path command and error data to the aircraft via the UHF Data Link. In operation, the radar tracks a point source (radar beacon) on the aircraft to determine aircraft position in spherical coordinates, with coordinate origin at the antenna. In the landing control central computer, radar target data are converted to rectangular coordinates and then translated to the intended touchdown point. A rotation through Euler angles of ship motion is then performed to give target position in a stable horizontal coordinate system with origin at the mean position of the intended touchdown point (X axis along the landing area centerline and Z axis along local vertical). A stable altitude command is determined as a function of aircraft range and certified glideslope. Deviation from commanded altitude is the altitude error. Aircraft lateral position with respect to the landing area centerline is the lateral position error. These flight path errors are converted into the pitch and roll correction commands and are transmitted through a UHF FSK data link to the aircraft. The commands are coupled into the aircraft autopilot to fly a desired path in a space-stabilized coordinate system. In the last 12 seconds of flight, deck motion is compensated for by varying the command altitude path causing the aircraft to fly to a projected touchdown point. This is accomplished by phase-advancing the ships vertical motion by a deck motion compensation filter and adding this filtered motion to the stable command altitude. This signal is gradually introduced over a 2-second span at the 12-second mark. The cockpit **10 second** light is illuminated to indicate the initiation of this circuit. The aircraft then flies an unstabilized altitude in phase with the ships motion to the projected touchdown point. Flight path error data which the pilot uses as a system monitor are also transmitted to the aircraft during a Mode I approach.

7.3.5 System Waveoff. The term waveoff as used with the SPN-46A may be confusing. Waveoff means the SPN-46A is no longer capable of safely controlling the aircraft. It is not necessarily a requirement for the pilot to execute a waveoff maneuver but rather indicates an uncoupling of the data link. The only time a waveoff maneuver is mandatory is when the LSO generates a waveoff. The LSO waveoff is coupled with the AN/SPN-46A and the FLOLS so that is indicated on the pilot's data link display as well as the FLOLS.

An AN/SPN-46A waveoff of a Mode I approach may be initiated by the pilot, the LSO, the final controller, the Air Boss or automatically by the computer subsystem. The pilot may terminate the approach and landing sequence at any time. The LSO may initiate waveoff at ranges less than 1 mile. Pressing the LSO waveoff control button (pickle switch) activates the Fresnel Lens optical waveoff system and causes the computer subsystem to enter a program which aborts the landing sequence, and returns the radar to the search mode. While the lens waveoff system is activated whenever the LSO presses the pickle switch, the AN/APN-46A only transmits LSO waveoffs to aircraft that are less than one mile from touchdown. This is necessary to prevent inadvertent waveoff of an aircraft at two miles when the aircraft in the groove is waved off. At any time prior to 5 seconds to touchdown, the final controller may initiate a "waveoff" sequence at his discretion. The computer subsystem compares the programmed flight path and aircraft position along the glideslope. Whenever the aircraft is outside of the normal maneuvering zone and would require an unsafe maneuver to return to the required glideslope or whenever one of the numerous system monitors detects a system malfunction, automatic system waveoff sequence is initiated. During the final 5 seconds before touchdown, both the final controller and the automatic waveoff is inhibited in the computer subsystem and only an LSO waveoff may be transmitted to the aircraft. The automatic waveoff may be disabled by the final controller in the event a landing aircraft is low on fuel, damaged, or otherwise unable to reenter the landing pattern. Because of a closed or fouled deck, and PALS waveoff can be initiated from the Primary Flight Control Center (Pri-Fly), provided the time to touchdown is between 9 and 5 seconds. If deck closed is initiated at time exceeding 9 seconds before touchdown, the waveoff command will not be generated until 9 seconds before touchdown. Pitch and bank commands are frozen during the final one and one half seconds (approximately at the ramp) of a Mode I approach. Because uncoupling is not usually apparent to the pilot or the LSO a gold "uncoupled" light is mounted within LSO vision aft of the platform and flashes anytime the computer uncouples from the aircraft.

7.3.6 Approach Degradation/Termination. Under certain circumstances the PALS approach may be degraded or terminated. Possible causes may be:

1. CCA controller selects incorrect aircraft parameter. The controller may neglect to reset the APN-42 console after the previous aircraft's approach (previous aircraft may have been of different beacon or reflector height). Control will be different, normally much jumpier. The controller should notify the pilot if he discovers the error. An unlock requisition will be required.

2. Beacon problems. A side lobe lock occurs or the aircraft has a bad beacon system/corner reflector. Side lobe lock-on can normally be remedied by an unlock and reacquisition. A bad beacon/corner reflector system will necessitate a skin track Mode II approach.

3. No information received. Check for proper Data Link Frequency. Ask CCA controller to check for proper address set. If the SPN-42 locks on but the correct address is not set, an unlock and requisition will be required for Modes I, IA, II. Indications of a malfunction are also indicated when the controller reports, "PALS LOCK-ON", but improper discrete lights are illuminated. The approach can be continued Mode III.

7.3.7. SPN-42 Unlock. If, at any time during the approach, an unlock of the SPN-42 becomes necessary, it may require up to 20 seconds for the controller to reacquire the aircraft. Depending on the aircraft's distance from the ship and problems with the system, it may be necessary to continue the approach using the backup Mode III only, or initiate waveoff. Glideslope and azimuth indicators on the LSO's SPN-42 panel give immediate indication of approach deviations and also helps trainees in calibrating their eye, especially in relation to lineup. The distance readout verifies which aircraft the radar is locked on. The readouts are helpful during Mode I, IA or approaches when few controller transmissions are made and there may be some question how far out the aircraft is or which final frequency is being used. Readout of true or closure speed verifies proper aircraft configuration and is useful in ascertaining that maximum arresting speeds are not exceeded. See LSO panel for description of LSO AN/SPN-46A panel.

7.3.8 Self-Contained CCA. As a last resort pilots must fly a self contained glideslope using altitude and DME references. *(See Figure 7-7).*

7.3.9 AN/SPN-46. The SPN-46 is an updated and improved follow-on replacement for SPN-42. The following changes are virtually invisible to the LSO, yet should improve the reliability of the system as a whole:

1. New dual band antenna uses an X-band monopole receiver that can recognize side lobes and then steer antenna onto the main lobe of the aircraft's beacon. This eliminates the need for an actual skin paint of the aircraft and greatly improves the range and probability of acquisition during heavy rain.

2. The new system utilizes more standard electronic boards and is now solid state. This improves the maintainability and reliability of the system.

3. The new system utilizes the Mk 16 Ring Laser Gyro. This provides greatly improved stabilization and is now independent of the ship's stabilization system.

4. The control console in CATCC is smaller and more compact, making it easier on the controller. Redundancy is built into each console, allowing either console to run both PALS channels in the event the other console is inoperative.

SPN-46 information to the LSO, via the HUD, is virtually the same as that provided using SPN-42 with the exception that airspeed (true/closing) will appear more accurate at a greater range. This is due to the decrease in time the system is using actual skin paint while trying to acquire lock-on.

All weather minimums, approach modes, procedures and acquisition windows remain the same as SPN-42.

7.4 SYSTEM CERTIFICATION

The AN/SPN-42A, AN/SPN-46 and AN/SPN-41 must be certified after initial installation and periodically thereafter to assure proper system operation and alignment. The certification involves electrical and underway flight tests. During the flight tests the various types of aircraft are controlled by the landing system under various environmental and system configuration situations. The certification report states the range of the various salient parameters that are allowable to assure aircraft automatic control.
These parameters include:

1. **Approach Weather Minimum.** Normally 200 feet (61m) ceiling above the flight deck and 1/2 mile (.926km) visibility.

2. **Wind Over Deck Conditions.** Limits are set for a given ship during certification process and very with aircraft type, glideslope angle, and type approach (Mode I, IA, or II). Check with Air Ops. Limits are generally in keeping with ARB's.

3. **Ship's Motion Conditions.** Normally not to exceed 2.0 degrees pitch (peak to peak), 5.0 degrees roll (peak to peak), and 7 feet heave (peak to peak).

4. **Ship's Static trim.** Typically 0.0 degrees bow down and up to 0.025 degree bow up.

5. **Angle of Attack Excursions** (Caused by Turbulence). Normally not to exceed plus or minus 1.5 units.

6. **Ship's Stabilization Systems.** Normally a carrier is equipped with the Ship's Inertial Navigation System (SINS) and two Mk 19 gyro compass systems. The report will specify which systems have been authorized for use.maneuver but

7. **FLOLS Glideslope.** Normally 3.5 degrees.

8. **AN/SPN-41 Glideslope.** Normally 3.5 degrees.

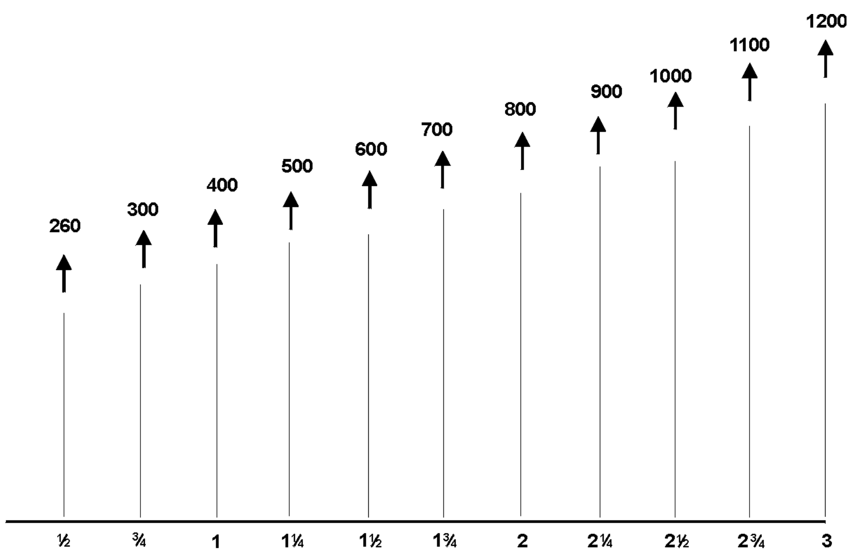


Figure 7-7 CV Self-contained CCA

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CHAPTER 8

LASER RANGE LINE-UP SYSTEM (LRLS)

This chapter will be added when information becomes available

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CHAPTER 9

SHIPBOARD ARRESTING GEAR

9.1 GENERAL

All U.S. Navy aircraft carriers have the Mark 7 Mod 3 arresting gear installed. Over the years, increased aircraft approach speeds and gross weights have necessitated increased arresting gear capacity to ensure safe recovery of these aircraft. Subsequent modifications to the original Mark 7 arresting gear have incorporated increased capacity and other significant improvements leading to the Mark 7 Mod 3 arresting gear which is the most capable system available today. It was initially installed on all CVs starting with the JOHN F. KENNEDY (CV-67) and subsequent carriers and all other carriers have been retro fitted during SLEP (Service Life Extension Program). However, many of these retrofitted CVs have retained one Mk 7 Mod 2 arresting engine as the barricade engine.

9.1.1 Mk 7 Mod 2. The Mk 7 Mod 2 is designed to recover a 50,000 pound aircraft at an engaging speed of 120 knots in a distance of 310 feet.

9.1.2 Mk 7 Mod 3. The Mark 7 Mod 3 has the capability of recovering a 50,000 pound aircraft at an engaging speed of 130 knots in a distance of 340 feet. It is designed to absorb theoretical maximum energy of 47,500,000 foot-pounds at peak fluid pressure and maximum cable run-out.

9.1.3 Recovery Equipment. The recovery equipment, including the arresting gear and barricades, is commonly referred to collectively as the arresting gear. Actually the arresting gear includes only that part of the recovery equipment which is utilized in arresting aircraft by means of the aircraft's arresting hook. *(Figure 9-1* shows the general arrangement of a typical Mk 7 arresting engine.) *Figure 9-2* lists all the leading particulars of the Mk 7 Mod 2 and Mod 3 recovery equipment as discussed in this chapter.

9.2 DESCRIPTION

The five major systems that make up the Mark 7 recovery equipment are as follows:

1. Engine installation
2. Drive System
3. Wire support system
4. Deck gear
5. Barricade stanchions and controls

The recovery equipment controls are not a distinct system, but will be addressed as a separate system.

9.3 OPERATION

Aircraft arrestments aboard carriers are classified as a normal arrestment or an emergency arrestment.

9.3.1 Normal Arrestment. A normal arrestment is accomplished in the following manner. The arresting hook of an incoming aircraft engages one of four deck pendants. The force of the forward motion of the landing aircraft is transferred to the purchase cable, which is reeved around the movable crosshead and fixed sheave assembly on the arresting engine. The arresting engine is located in the arresting engine machinery room below the flight deck and the purchase cable is fed from the engine to the flight deck through a series of sheaves. The crosshead (movable sheaves) is attached to the ram of the ram and cylinder assembly. As the deck pendant and the purchase cable are pulled out on the flight deck by the aircraft being arrested, the crosshead moves toward the fixed sheaves, which are attached to the engine frame at the opposite end of the arresting engine from the crosshead. As the crosshead moves toward the fixed sheaves, the ram is being pulled into the main engine cylinder, forcing fluid through a control valve to the accumulator. Fluid being metered through the control valve is the predetermined factor in bringing about a smooth, controlled arrestment of the landing aircraft.

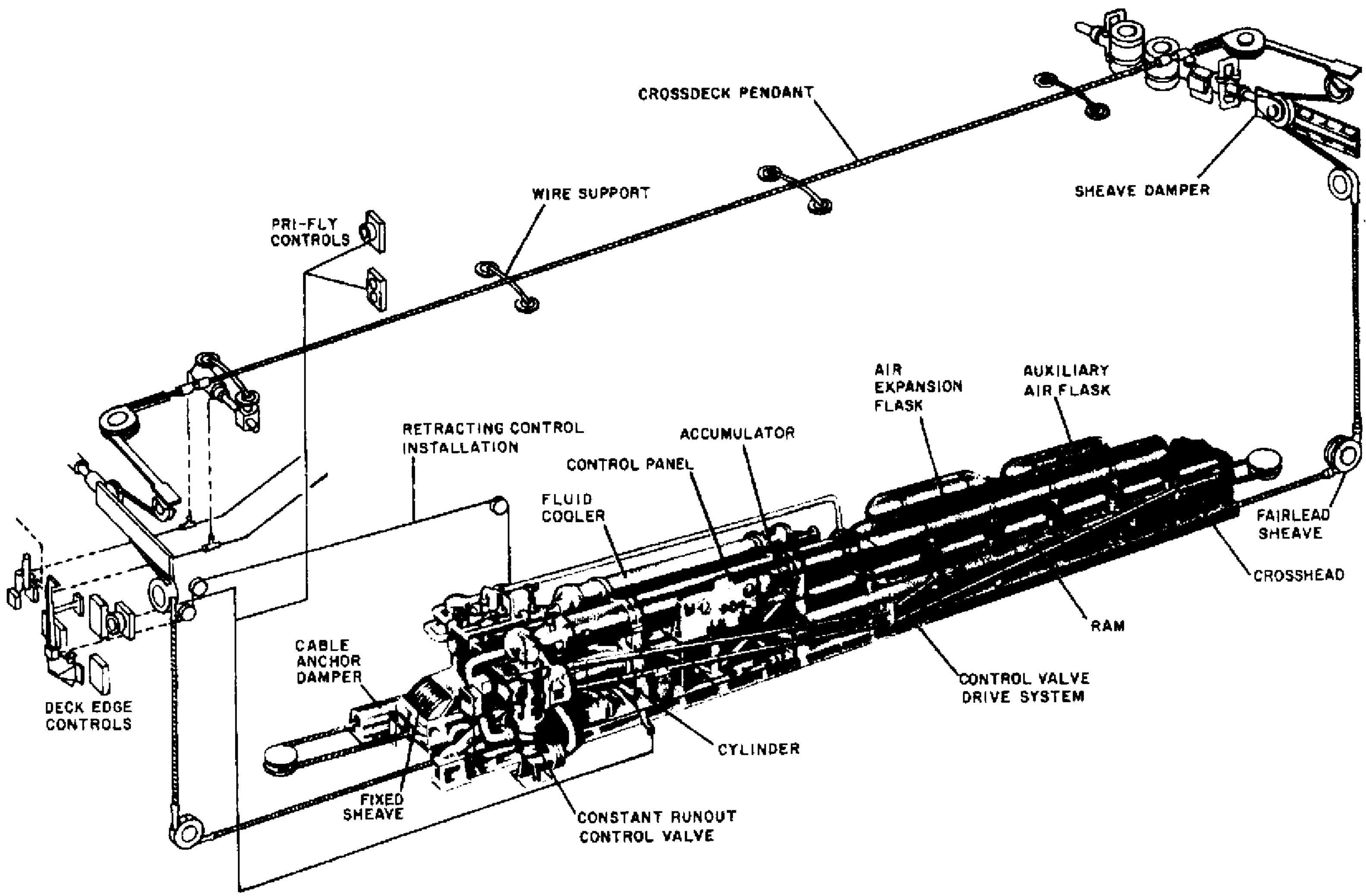


Figure 9-1 General Arrangement of Mark 7 Arresting Engine with Cooler

At the completion of the arrestment, the aircraft arresting hook is disengaged from the deck pendant and the deck pendant is returned to its normal position by the following action. A retracting control lever, located at the deckedge control station is operated to open the retracting valve.

Opening the retracting valve allows fluid to be forced from the accumulator via the fluid cooler into the engine cylinder, forcing the ram and crosshead back to its battery position. As the crosshead moves, the purchase cable is pulled back into the engine, returning the deck pendant to its normal position. The normal arresting sequence is illustrated in *Figure 9-3*.

MAXIMUM ENERGY ABSORPTION:	**Mod2**	**Mod3**
Service stroke	38,373,000 lb.-ft.	47,500,000 lb.-ft.
ENGINE DRIVE SYSTEM CABLES: (Breaking strength / diameter)		
Deck pendant (6 X 30 flattened strand)	188,000 lb. / 1 7/16 in.	188,000 lb. / 1 7/16 in.
Purchase cable (6 X 25 round strand)	175,000 lb./ 1 7/16 IN.	175,000 lb ./ 1 7/16 IN.
Reeving ratio	18 to 1	18 to 1
ARRESTING ENGINE		
Length	50 ft.	50 ft
Weight	37 tons	43 tons
Engine fluid	Ethylene glycol	Ethylene glycol
Engine fluid capacity (without cooler)	320 gal.	380 gal.
Engine fluid capacity (with cooler)	500 gal.	560 gal.
Length of maximum stroke	186 in.	192 in.
Length of service stroke	171 in.	183 in.
Accumulator operating medium	Ethylene glycolair	Ethylene glycolair
Maximum pressure	650 psi	650 psi
Initial working pressure	400 psi	400 psi
Type of coolant	Sea water	Sea water
Length of runout	310 ft.	340 ft.

Figure 9-2 Leading Particulars of Mk 7 Mod 3 Recovery Equipment

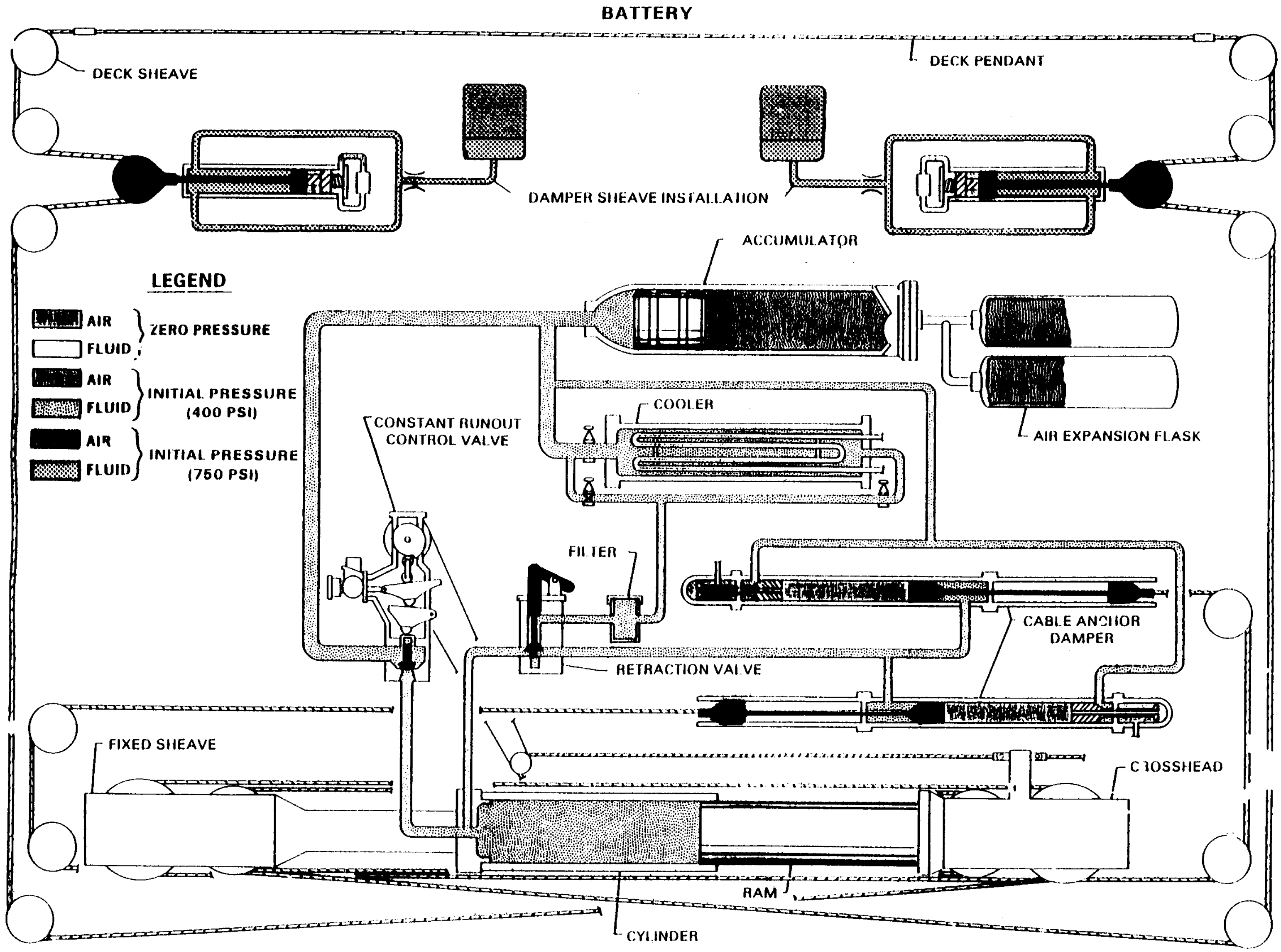


Figure 9-3 Normal Arresting Sequence

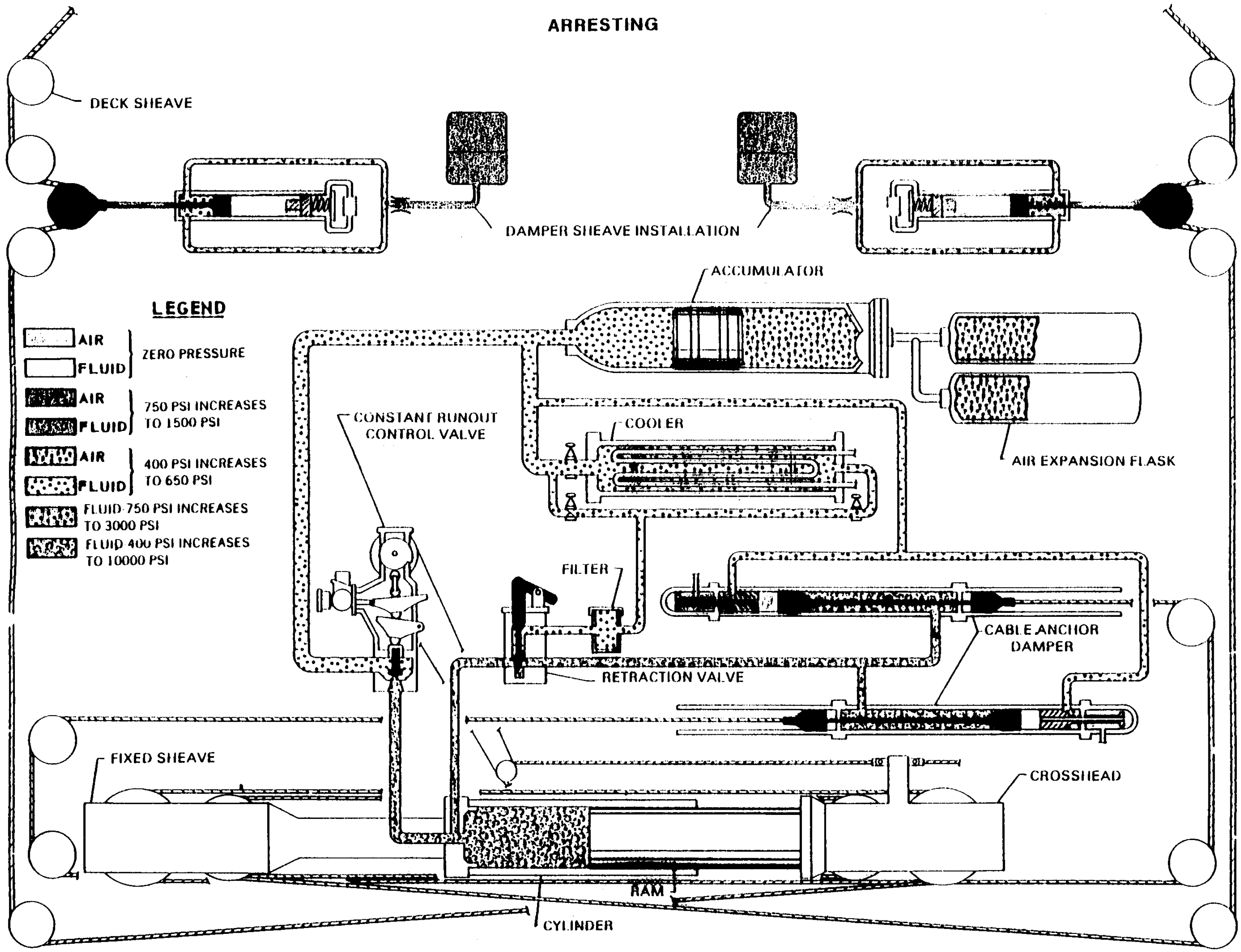


Figure 9-3 Normal Arresting Sequence

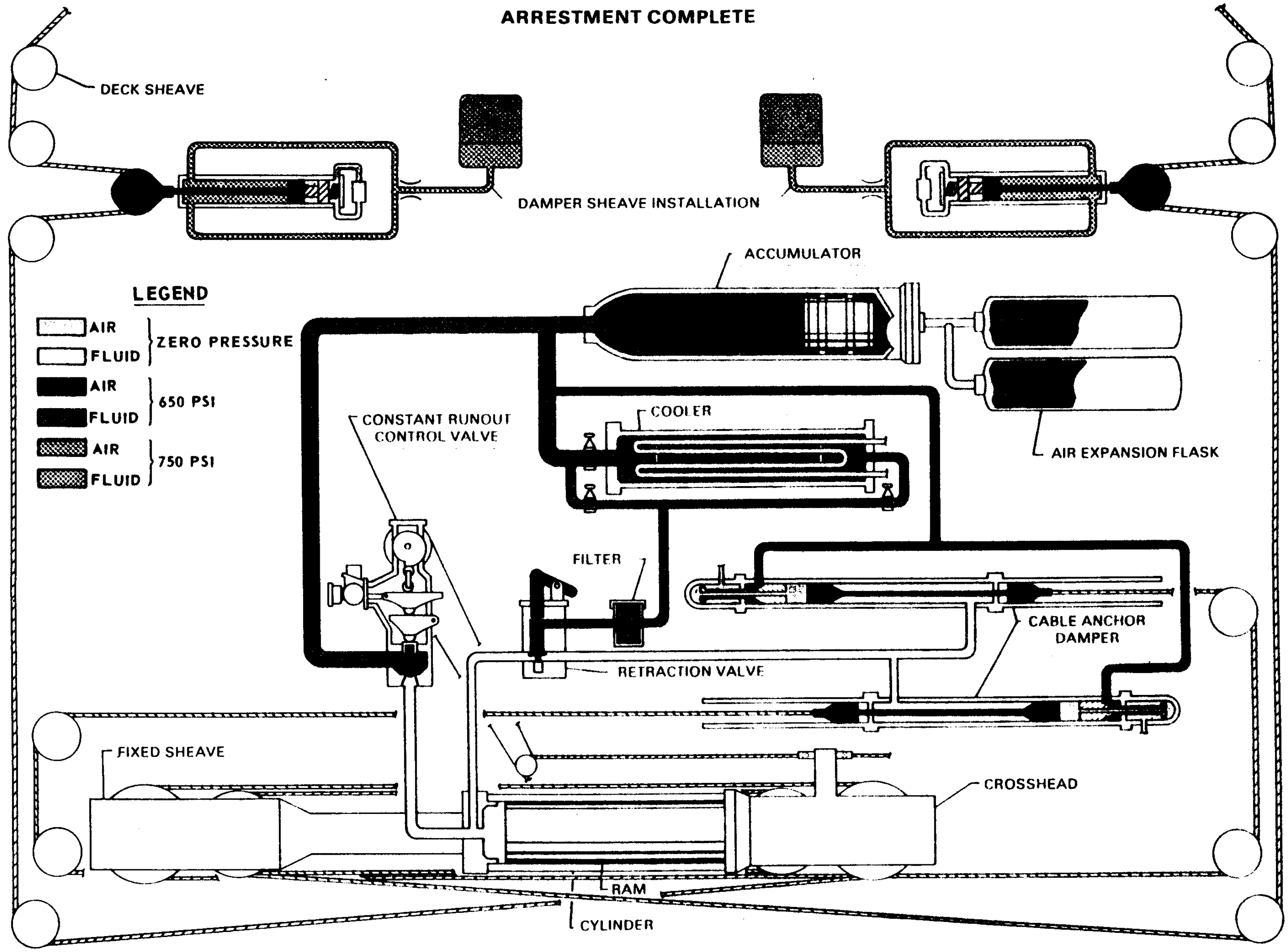


Figure 9-3 Normal Arresting Sequence

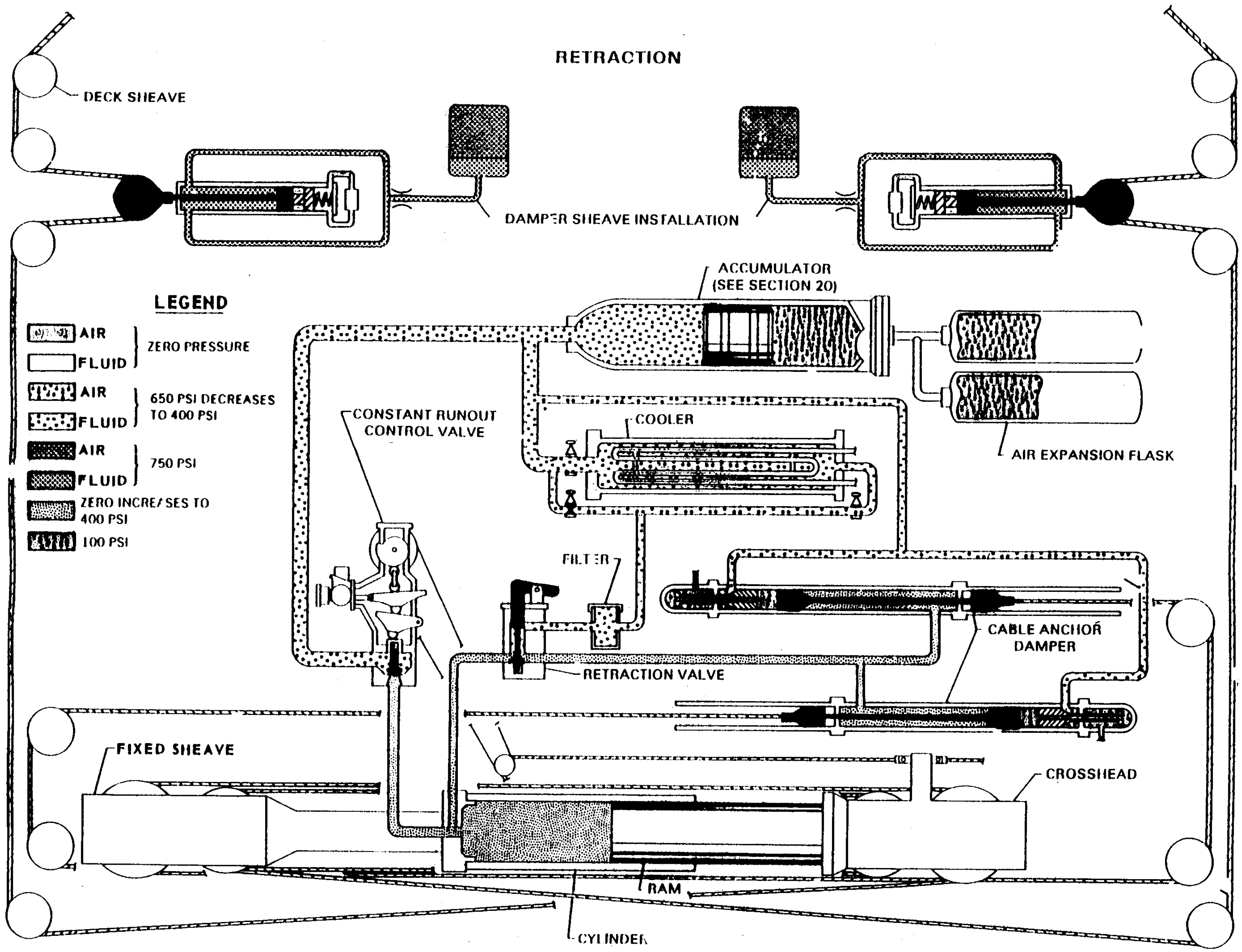


Figure 9-3 Normal Arresting Sequence

9.3.2 Emergency Arrestment.

WARNING

For applicable aircraft barricade engagement restrictions, the specific aircraft NATOPS manual is the final clearance authority and MUST be consulted for clearance with specific gear configuration.

The emergency recovery equipment (barricade) *(Figure 9-4)* is used only when a normal (pendant) arrestment cannot be made. The barricade installation is normally in a stowed condition and rigged only when its use is required. To rig a barricade, the barricade triple webbing is removed from storage, stretched across the flight deck between stanchions, and secured to the upper and lower tensioning pendant.

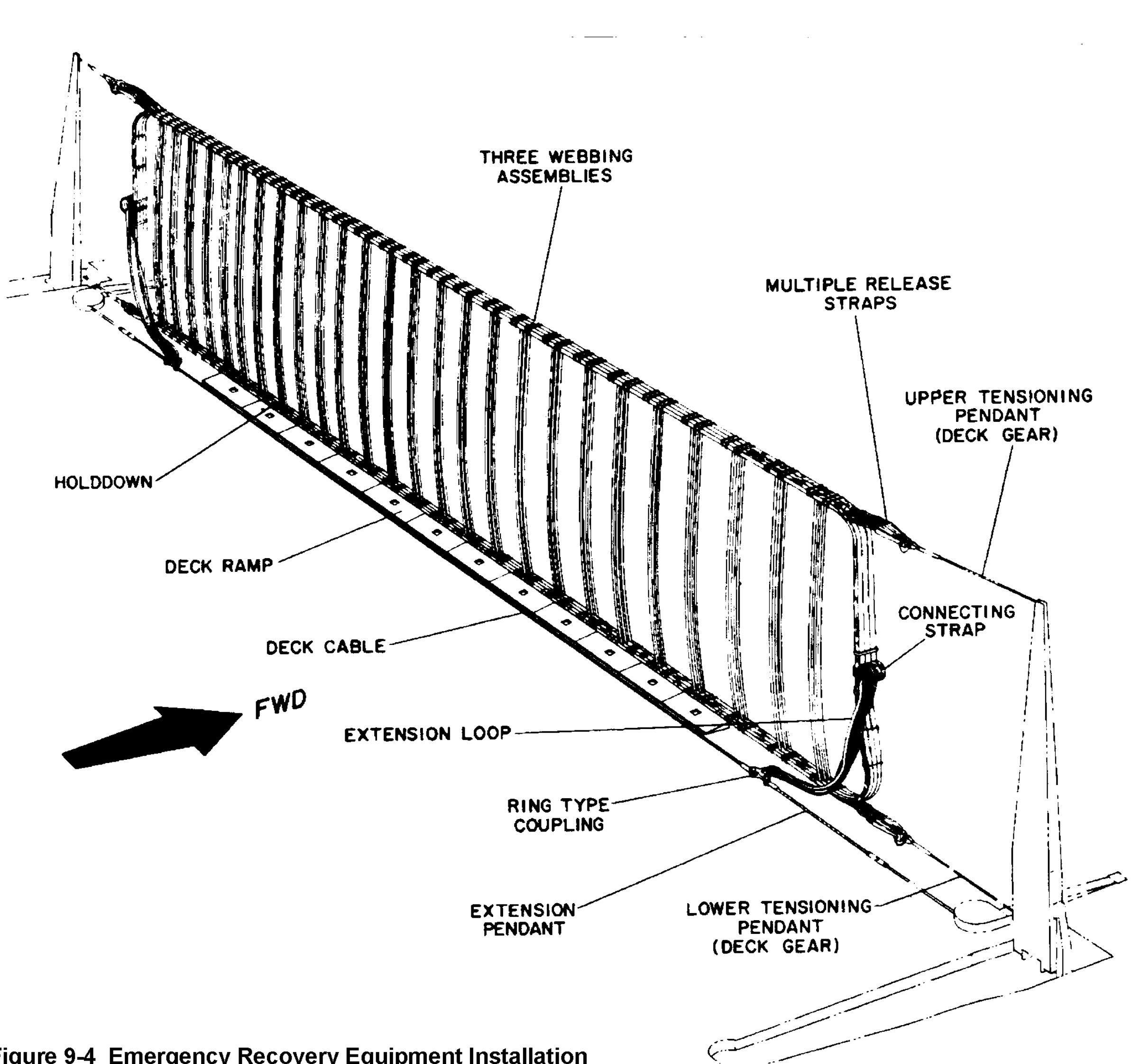


Figure 9-4 Emergency Recovery Equipment Installation (Jet Aircraft)

NOTE

A special double webbing assembly *(Figure 9-5)* is used for the E-2/C-2 aircraft which helps prevent damage to the engine reduction gear by allowing clearance for the turboprop in the center section of the webbing assembly. The extension pendants are secured to the purchase cable coupling, deck ramps are clamped to the flight deck and the lower load straps are tucked under U-shaped holdowns *(Figure 9-4).*

From their recessed slots in the flight deck, the barricade stantions are raised to the vertical position by operating the controls at the deck edge control station and the barricade hydraulic control installation. The barricade webbing is centered and tensioned with the stanchions and deck winches to a height of 20 feet measured at the center of the webbing.

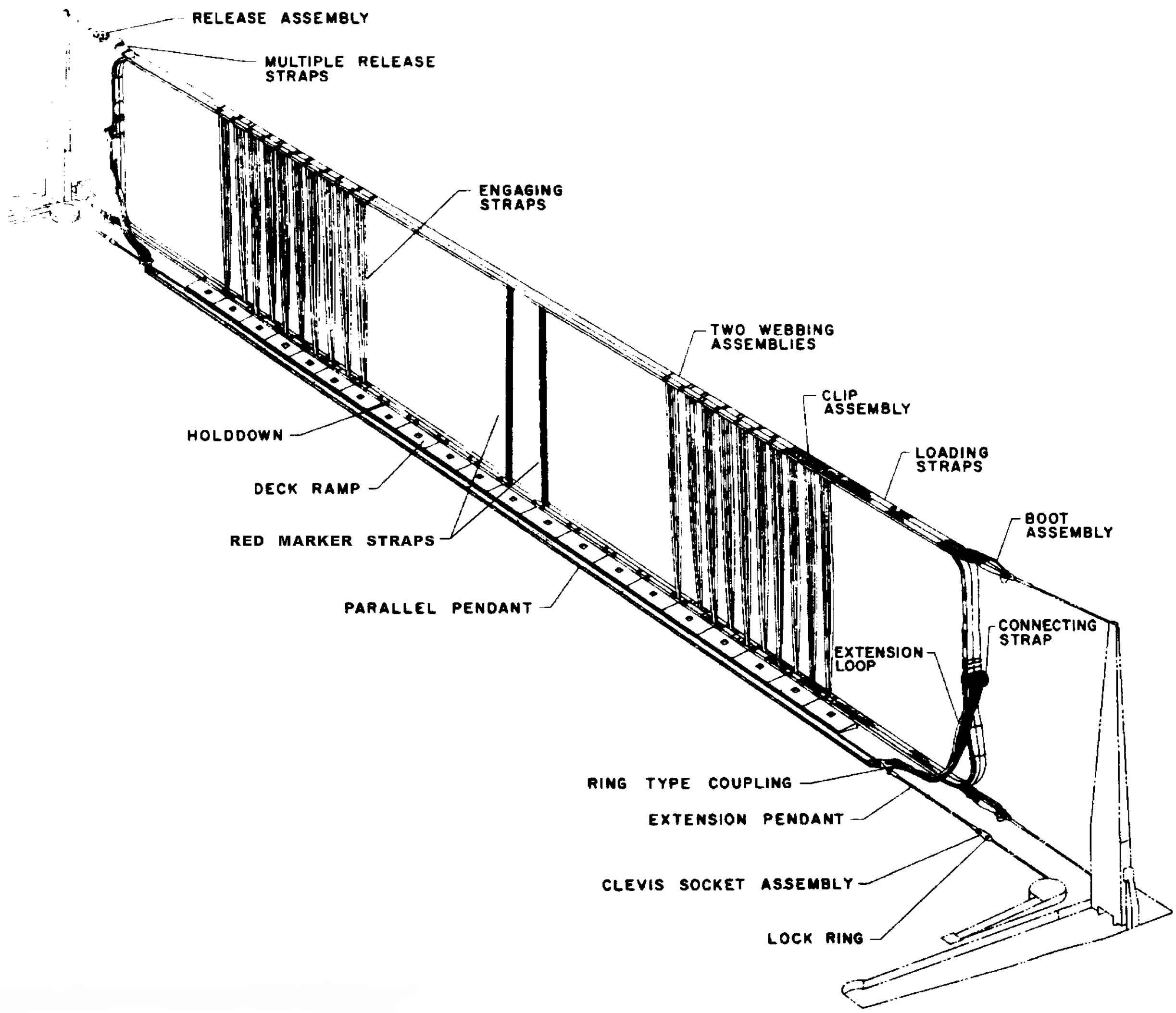


Figure 9-5 E2/C2 Aircraft Barricade

The barricade is now ready for an emergency arrestment.

When the barricade webbing is engaged by the aircraft, it is engaged by the wings of the aircraft. The tension created by the engagement breaks the release straps, which connect the webbing loops in the into the release assembly. The progressive failure of multiple straps produces a lower release load in tensioning pendants and improves the barricade arrestment. The energy is then transmitted from the barricade webbing through the purchase cable to the arresting engine.

Following a barricade arrestment, the webbing and deck cables are discarded and the stations are lowered back into their recess slots.

9.4 ARRESTING GEAR

The Mark 7 arresting engine is a hydro-pneumatic system composed basically of the engine structure, a cylinder and ram assembly, the crosshead and fixed sheaves, a control valve system, the accumulator system, auxiliary air flasks, and a sheave and cable arrangement.

The function of the arresting engine is to absorb and dispel the energies developed when a landing aircraft is arrested. As shown in the diagrams in *Figures 9-3 and 9-6*, the fluid is forced out of the cylinder by the ram, through the control valve.

9.4.1 Engine Structure. The engine structure is a framework of supporting the engine and most of its components and for securing the entire assembly to the ship's structure. It is composed of a welded steel base made in two longitudinal box sections with the necessary ties, plates, and other structural members. The two sections are bolted together near the center. Two pairs of saddles are mounted on the base for supporting the engine cylinder. Vertical stands are welded on these saddles to support the saddles for the accumulator. Between these two stands is a frame of welded channels, angles, and gusset plates to provide trusses and ties for the frame.

On the crosshead end of the welded base support plates, webs and gussets support the rails for the crosshead. On this end of the base are welded longitudinal guides for the accumulator assembly. Near the end of this frame and bolted to it, is the crosshead stop which is removed when the crosshead is installed or removed.

9.4.2 Cylinder, Ram and Elbow Assembly. *(Figure 9-6)* The cylinder and ram assembly constitutes the actual "engine" of the arresting gear, and is located within the engine structure between the elbow assembly and movable crosshead.

When the engine is actuated through pull of the purchase cable, movement of the crosshead pushes the ram into the cylinder (cylinder is full of fluid when arresting engine is in "Battery" position) and forces the fluid through a metering orifice of the control valve into the accumulator. The forces of arrestment are absorbed in the increased fluid pressure of the cylinder and air pressure of the accumulator. During retraction, fluid returns to the cylinder and forces the ram to push the engine crosshead to "Battery" position.

9.4.2.1 Cylinder and Elbow. The arresting engine cylinder *(Figure 9-6)* is the receiver and guide for the ram. It is also a reservoir for the engine fluid. The fixed sheave assembly end of the cylinder is attached to the engine elbow outlet. This attachment and two saddles, which are part of the engine structure, provide support for the cylinder. The free end of the cylinder is provided with a wiper to remove dirt from the ram as it moves into the cylinder.

9.4.2.2 Ram. The ram *(Figure 9-6)* acts as a large piston which moves in and out of the engine cylinder during an arrestment cycle. The ram is attached to and moves with the crosshead assembly. The cylinder end of the ram rides in the cylinder on slippers and also has V-ring packings which prevent fluid from leaking out of the cylinder.

9.4.2.3 Two-Blocking. Should excessive runout occur during an arrestment, the engine ram will continue past the normal "arrestment complete" position and force the engine crosshead against the cylinder. this is a condition known as "two-blocking." To prevent metal to metal contact of the crosshead and cylinder during a two-blocking condition, a wood block assembly is bolted on the engine ram in the front of the crosshead. Two-blocking occurs when the ram reaches 195 inches.

9.4.2.4 Ram Travel. The following are factors which might contribute to ram overtravel and should be closely monitored.

1. Excess aircraft gross weight for specified Aircraft Recovery Bulletin speeds.
2. Excess aircraft engaging speed for specified Aircraft Recovery Bulletin weights.
3. Large increase of airplane thrust applied during the arresting runout, over normally applied thrust.

CAUTION

Careful monitoring of steps 1 and 2 above, with attention to both accuracy of speed indicator readings and actual aircraft weights, is imperative. Errors in these values can be large factors in arresting gear overtravel. Also, engagement with one or both afterburners operating (step 3 above) will almost always produce ram overtravel. Make certain to check appropriate Recovery Bulletins for detailed instructions.

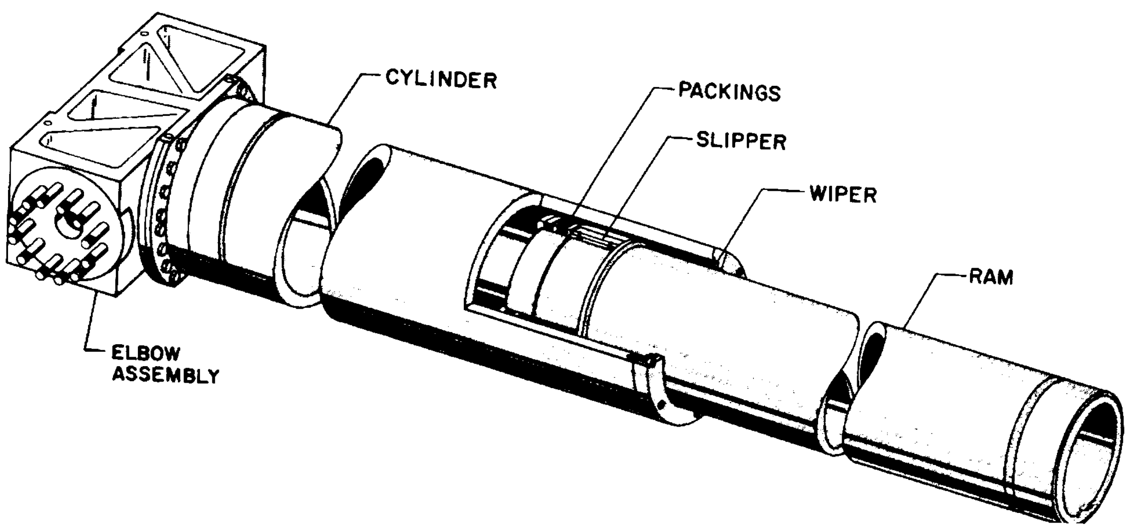


Figure 9-6 Cylinder, Ram, Elbow

9.4.3 Crosshead and Fixed Sheaves Assembly.

9.4.3.1 Fixed Sheave Assembly. The fixed sheave assembly *(Figure 9-1)* is secured to the engine structure and consists of two banks of rotating sheaves. There are nine sheaves in each bank and each bank is mounted on an individual shaft. The external sheaves are 33 inches in pitch diameter, and the internal sheaves are 28 inches in pitch diameter. The diameter differential is necessary for purchase cable clearance. The cable guards and fairlead guides, mounted on the top and bottom of the fixed sheave body, retain the purchase cable in sheave grooves and provide protection from dirt or other foreign matter.

9.4.3.2 Crosshead Assembly. The crosshead assembly *(Figure 9-1)* is secured to the outer end of the engine ram by ring segments, which fit into grooves around the end of the ram. The sheave arrangement for the crosshead is the same in the fixed sheave assembly. Fairlead tubing is secured to the ram end of the crosshead body to guide reeved purchase cable to the fixed sheave assembly. Since the crosshead assembly moves with the ram, slippers are mounted on each corner of the crosshead body and are held in place by brass retainers. The slippers ride on tracks on the side of the engine structure. These slippers support the weight of the crosshead and act as a guide to keep the crosshead level during operations. When the engine crosshead is fully extended at the end of the retraction operation, it is in "Battery" position. When arrestment occurs, the crosshead assembly is forced toward the fixed sheave end of the arresting engine.

9.4.4 Constant Runout Control Valve Assembly.

9.4.4.1 General. A major development in arresting gear is the constant runout control valve. With this valve installed, the arresting engine is capable of stopping all aircraft that engage a given deck pendant at approximately the same spot regardless of the weight and speed (within limits specified in the recovery bulletins) *(Figure 9-7)*. It makes possible the use of a longer service stroke of the ram than was possible with former valves. The use of a longer service stroke increases the capacity of the arresting engine. All carrier arresting gear is now equipped with constant runout control valves.

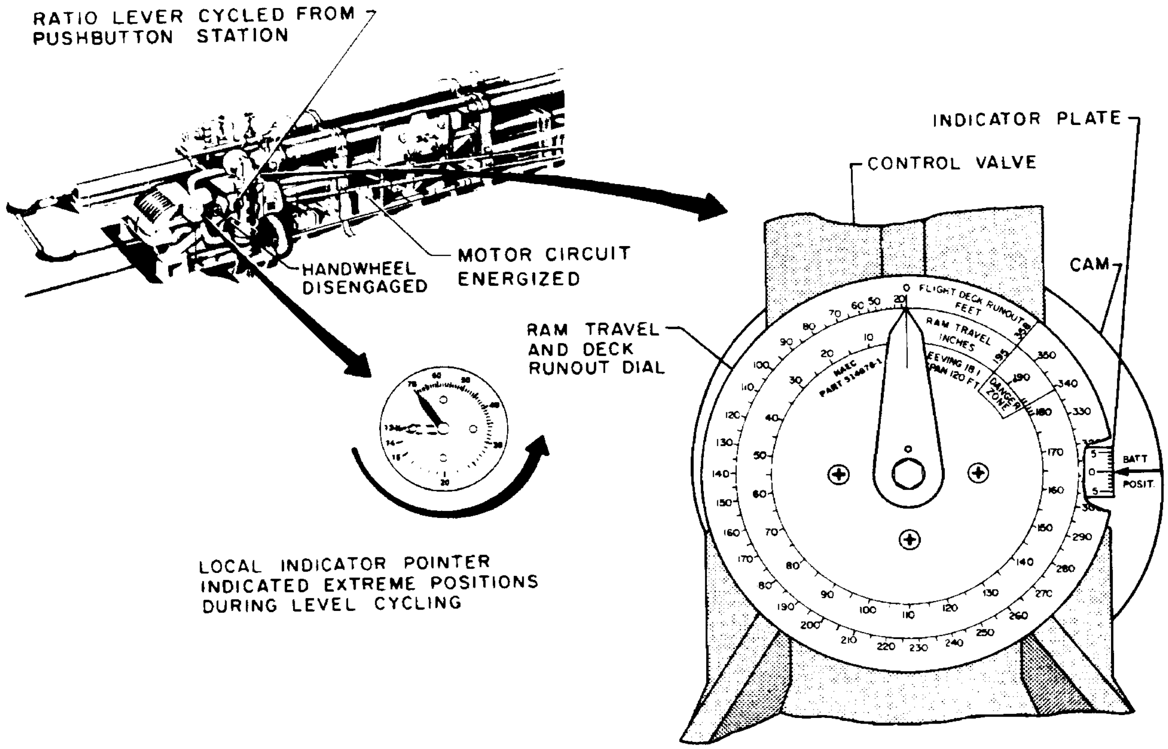
9.4.4.2 Constant Runout Control Valve Operation. The constant runout control valve and drive system provide for controlling the fluid flow from the engine cylinder to the accumulator. The constant runout (CRO) valve is installed at the fixed sheave end of the Mk 7 arresting engine as illustrated in *Figure 9-1*.

The constant runout control valve drive system *(Figure 9-7)* translates the movement of the crosshead into cam rotation. Cam rotation controls the opening and closing of the control valve. The adjustable anchor assembly, secured to and moving with engine crosshead, pulls the cable and chain drive system. Roller chain movement drives the sprockets and rotates the cam. The ram travel and flight deck runout dial translates the cam motion into ram travel (inches) and flight deck runout (feet). When the dial indication does not coincide with the position of the engine crosshead, the adjustable anchor assembly must be adjusted to correct to misalignment.

The control valve of constant runout *(Figure 9-8)* is designed to stop all aircraft with the same amount of runout regardless of the weight and speed (within limits specified in the recovery bulletins).

The Constant Runout Control Valve Assembly has four major components; the control system, the arresting valve, the aircraft weight selector, and drive system.

The arresting valve is the heart of the equipment. It is the main valve which controls the flow of fluid from the cylinder of the arresting engine to the accumulator. The remainder of the equipment is used either to adjust the initial opening of this valve for aircraft of different weight, or to activate the valve during the arresting stroke. The retracting valve is used to return the fluid from the accumulator to the cylinder and is operated independently of the control valve.



Control Valve Cam and Aircraft Weight Selector Unit

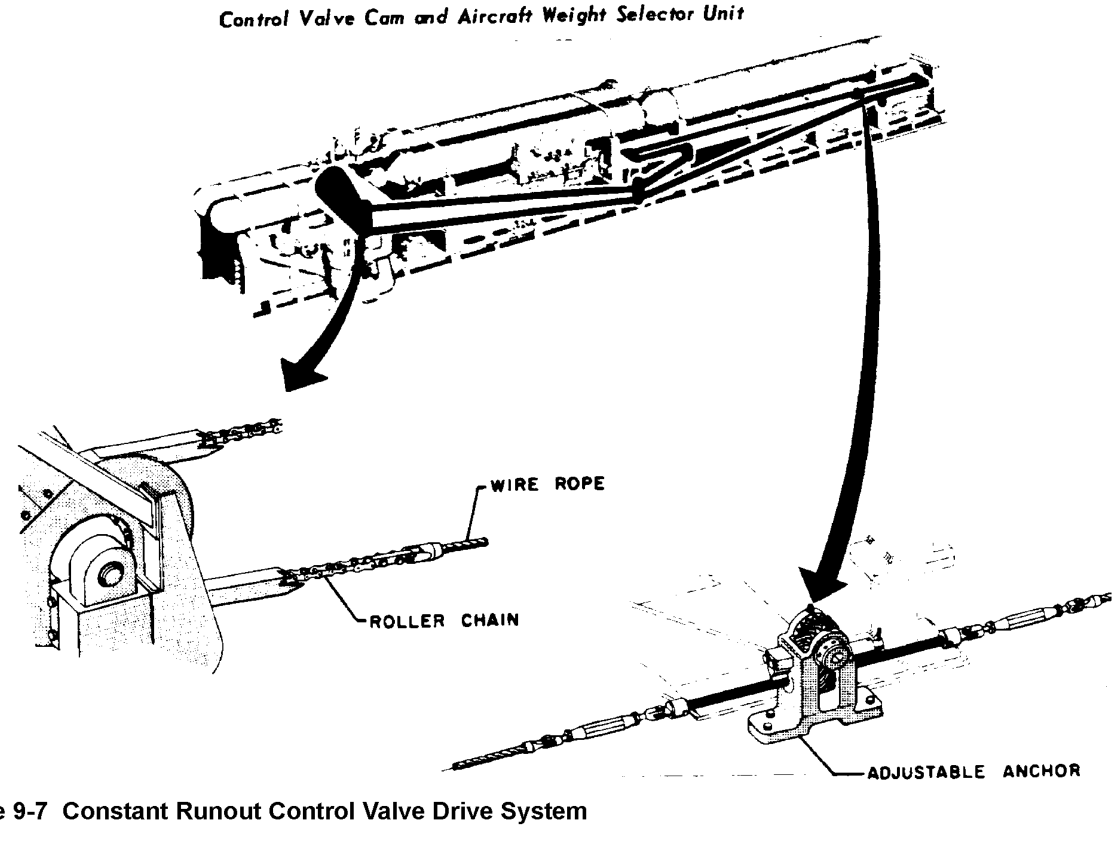


Figure 9-7 Constant Runout Control Valve Drive System

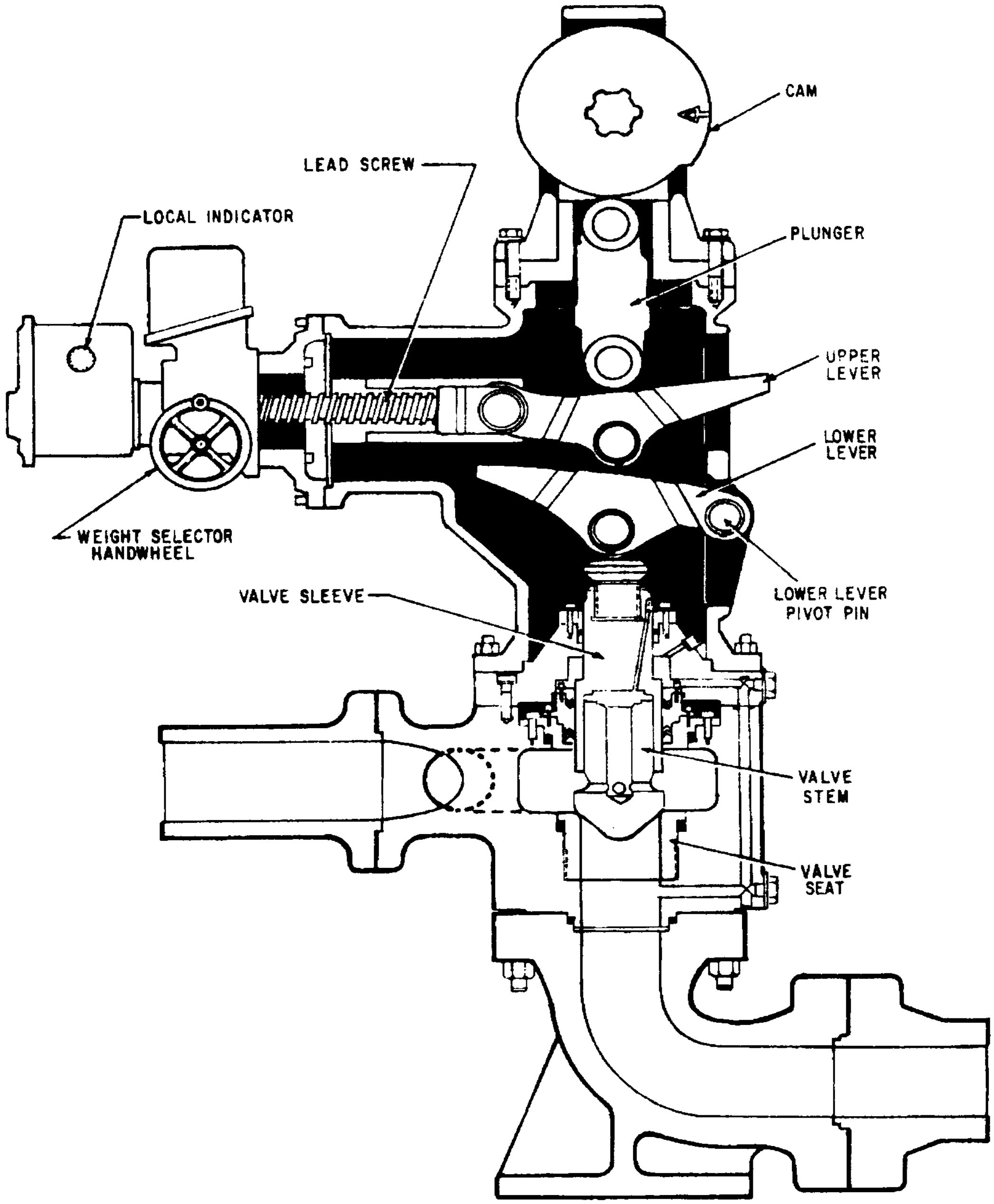


Figure 9-8 Sectional View of the MK Mod 3 Control Valve

When a landing aircraft engages a deck pendant, or barricade, it withdraws purchase cable from the arresting engine. this action causes the crosshead to move toward the fixed sheave end of the engine. In addition to displacing fluid from the cylinder, this movement of the crosshead activates the drive system, causing rotary motion of the cam in the cam and plunger assembly.

Aircraft Weight Selector. It is necessary to have a smaller valve opening to arrest heavier aircraft, and a large valve opening to arrest lighter aircraft. The aircraft weight selector makes it possible to adjust the valve for aircraft of different weights by varying the valve opening *(Figure 9-8)*.

The size of the initial valve opening is adjusted while the arresting engine is in battery position. The lead screw receives rotary motion from the motor unit or handwheel and converts it into linear motion. This linear motion positions the upper lever and drives the local and remote indicators.

In each of the two levers (upper and lower), the distance between the fulcrum and roller is constant. On the upper lever, the distance between the fulcrum and the point of application of force from the cam is variable, its greatest length being twice that of the lower lever. The lever arm ratio of each lever, therefore, is variable between 1:1 and 2:1.

When the upper lever is fully extended, the ratio of each lever is 1:1. In this setting the initial opening of the control valve upon engagement of an aircraft is maximum. The levers are in a 1:1 ratio in *Figure 9-8*. The resulting rotation of the cam, caused by the crosshead moving inward, forces the plunger downward. A plunger movement of 1 inch, acting through the upper lever, would move the lower lever 1 inch; the lower lever, in turn, would move the valve sleeve and stem 1 inch downward.

The cam is of the disc plate type with the desired contour machined on its periphery. As the cam rotates, it forces the plunger down. The plunger is fitted with rollers, top and bottom.

The bottom roller on the plunger acts against the top flat bearing surface of the upper lever. The pivot end of the upper lever has a bushed hole which is pinned to the clevis end of the lead screw yoke. The upper lever is connected to the clevis end of the yoke by a pin. This connection provides the means by which the lead screw adjusts the upper lever.

The bottom of the upper lever is fitted with a roller which bears against the flat surface of the lower lever. One end of the lower lever has a bushed hold to receive a pivot pin. The pivot pin passes through the lever and through two mounting holes in the stanchion.

The bottom of the lower lever is fitted with a roller which bears on the stem screw on top of the valve sleeve. The vertical position of the roller on the lower lever determines the vertical distance that the valve sleeve may move. Thus, it controls the size of the initial opening of the control valve.

The levers are mounted in such a way that, as the upper lever is withdrawn, the lever arm ratio of both levers is increased by an equal amount. When the upper lever is fully withdrawn, the ratio of each lever is 2:1, and the ratio through the lever system (upper and lower levers) is 4:1. In this case the initial control valve opening is minimum. A plunger movement of 1 inch, acting through the upper lever, would move the lower lever 1/2 inch; the lower lever, in turn, would move the valve sleeve and stem 1/4 inch downward.

A critical point to consider is the position of the levers when the valve stem is seated by cam action at the termination of each arrestment stroke. the levers are so mounted and adjusted that the bearing surfaces of the levers are level when the valve is seated. When the bearing surfaces are level the distance across the lever system is the same regardless of the ratio setting. Because of this, the point closing of the valve is independent of the aircraft weight selector. It is a function of the cam only; therefore it is constant.

As the engine is retracted, the upper lever rises a distance equal to the movement of the plunger. If the ratio is 1:1, the valve sleeve rises the same distance. In this case the initial valve opening is maximum. If the ratio is 4:1, however, the valve sleeve rises only one-fourth the distance that the plunger moves. In this case the initial valve opening is minimum.

The lever setting may be adjusted to any setting within the two extremes previously discussed; the particular setting used is dependent upon the weight of the aircraft to be arrested. The weight setting is made with the engine in battery position prior to landing the aircraft. Adjustment of the setting determines the position of the valve sleeve. Therefore it also sets the amount of the valve sleeve will open at the beginning of the arrestment stroke. Similarly it determines the rate of closure during the stroke, so that the valve will always seat at the same runout. The valve stem sleeve allows a relatively unloaded and cushioned opening at the beginning of the stroke.

The lever system, if set for a heavy aircraft, reduces the allowable valve stem opening and thus increases the resistance of the valve to the flow of fluid. The energy of the aircraft is dissipated in forcing fluid through the restricted valve opening. The operation of the control valve assembly during a normal arrestment is shown in *Figure 9-9*.

9.4.5 Accumulator System. The accumulator and air expansion flask *(Figure 9-1*) are mounted in saddles on the engine structure. The accumulator is the receiving chamber for engine cylinder fluid displaced by the ram during arrestment. The air expansion flask contains the pressurized air for charging the air side of the accumulator cylinder. Two auxiliary air flasks (mounted on bulkhead) store ship's air supply, the auxiliary air system (accumulator and air expansion flask).

During arrestment procedures, the accumulator receives fluid from the control valve by way of fluid piping. This fluid forces the accumulator piston toward the air end of the accumulator, increasing pressure in the air expansion flasks from 400 psi to 650 psi. This increased air pressure is used to return engine fluid to the cylinder during retraction of the arresting gear.

9.4.6 Fluid Cooler. During continuous arresting operations, the engine fluid temperature rises due to friction of the fluid moving through the engine, control valve, and piping. To maintain extended pendant engine operation, the fluid temperature is reduced by the fluid cooler. The maximum operating temperature for all arresting engines is 160° F. Prolonged operation at this temperature limit is not recommended. For prolonged operation, a temperature of below 130° F must be maintained.

Fluid coolers are used only on Mark 7 arresting engines serving a deck pendant. Engine fluid, as it is returned from the accumulator to the main engine cylinder during retraction of the engine, flows through the fluid cooler body. Heat from the engine fluid is transferred to cool service water (salt water) flowing at 100 gallons per minute through tubes within the cooler body. The fluid cooler is mounted in saddles on top of the engine structure adjacent to the accumulator.

BATTERY

The valve stem is held closed by an unbalanced pressure force when the arresting engine is in its "BATTERY" position. The accumulator and engine cylinder pressures are identical but the pressure area on the accumulator side of the stem is large causing a force differential which holds the stem closed against the seat. The lever arrangement is forced against the cam by accumulator pressure on the valve sleeve. With this configuration, there is a gap between the valve stem and sleeve.

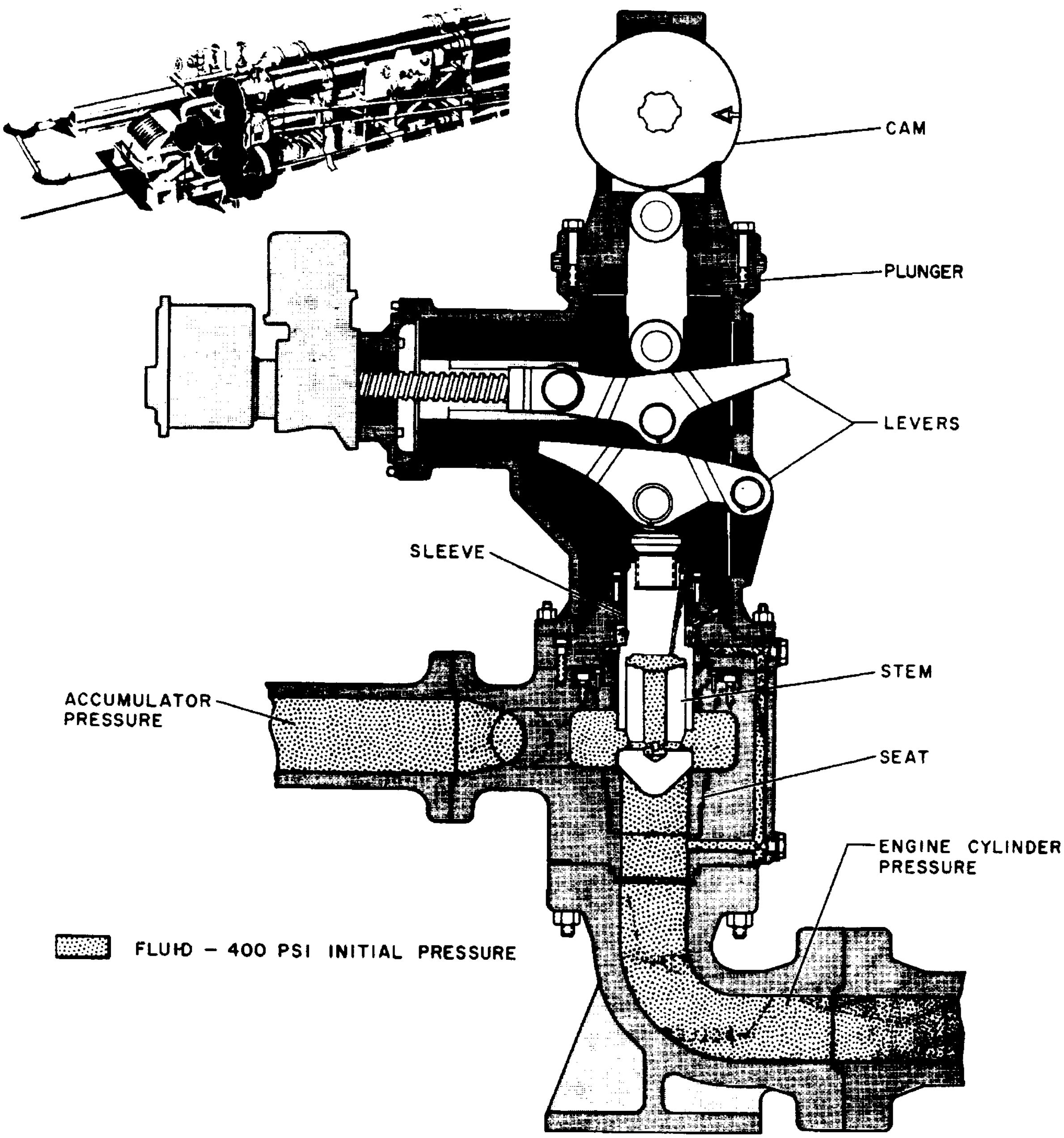


Figure 9-9a Constant Runout Control Valve Operation

ENGAGEMENT

The deck pendant is engaged by the arresting hook of an incoming aircraft. The engagement causes a sudden engine cylinder pressure build–up. The pressurized fluid unseats the valve stem and forces it upward into the sleeve permitting valve fluid to flow past the stem. The control valve drive system, motivated by movement of the crosshead, rotates the cam. As the cam rotates, the plunger forces the lever arrangement to move. This movement forces the sleeve toward the closed position. Continual high pressure in the engine cylinder keeps the valve open and continued cam rotation forces the valve sleeve to reset the stem.

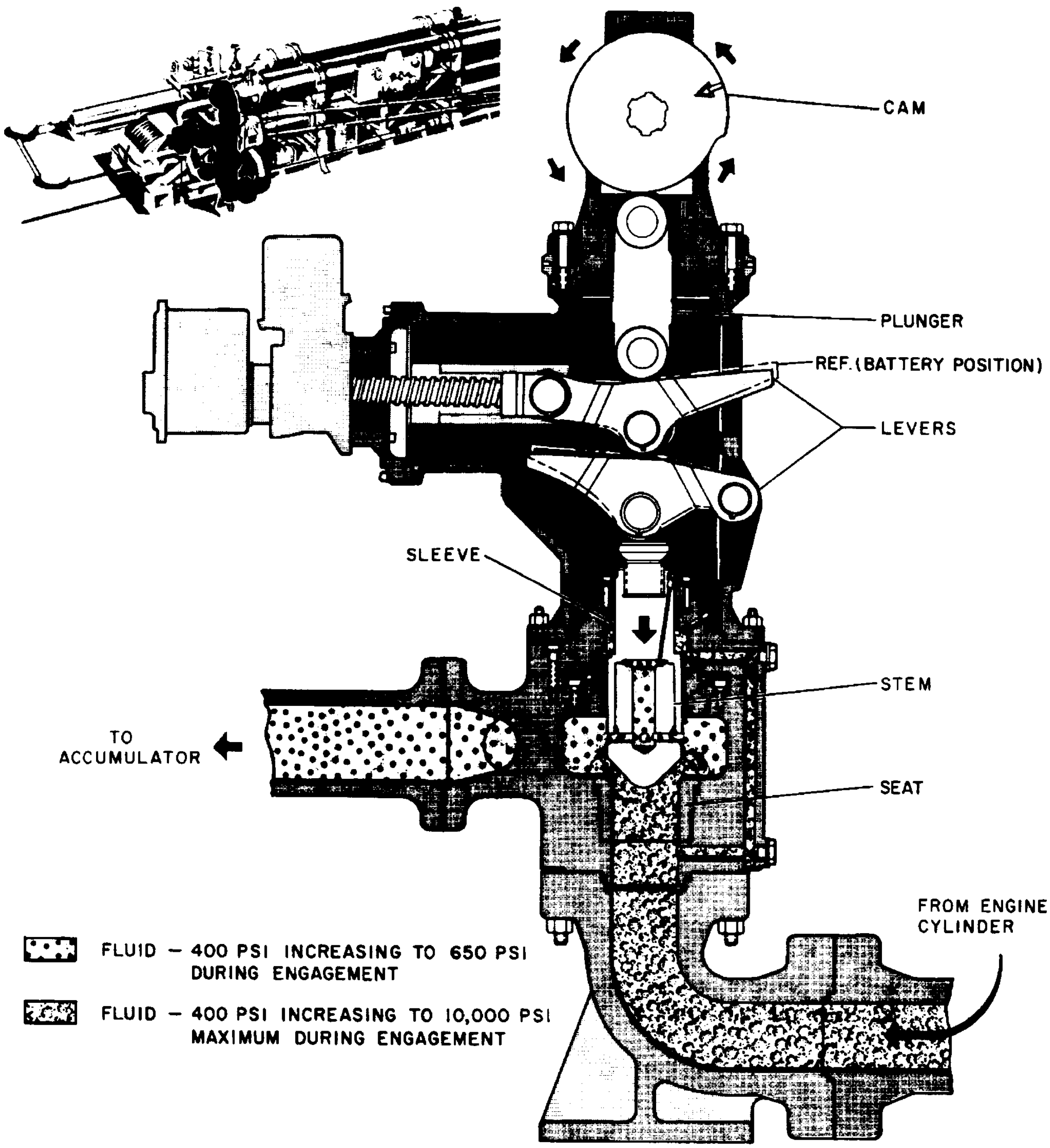


Figure 9-9b Constant Runout Control Valve Operation

RUNOUT

The control valve drive system, as the aircraft travels down the flight deck, continues to rotate the cam. This forces the lever system to push the valve sleeve and stem toward the closed position. (Pressurized fluid is also helping movement of valve sleeve by bearing against shoulder of sleeve.)

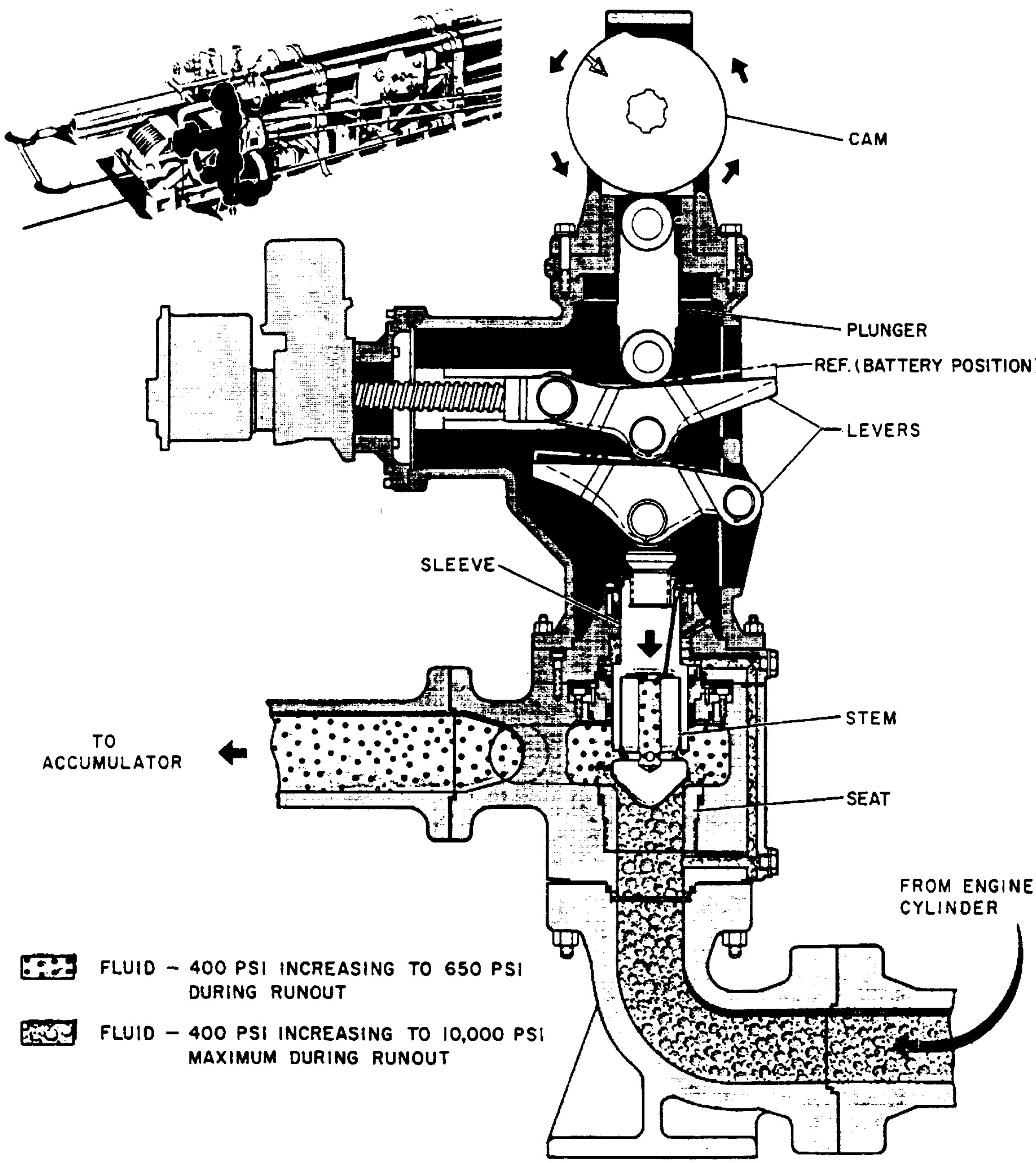


Figure 9-9c Constant Runout Control Valve Operation

ARRESTMENT COMPLETE

The cam rotation has reached the cam surface high point. The control valve is closed and the control valve drive system and crosshead motion is stopped. The aircraft arrestment is complete.

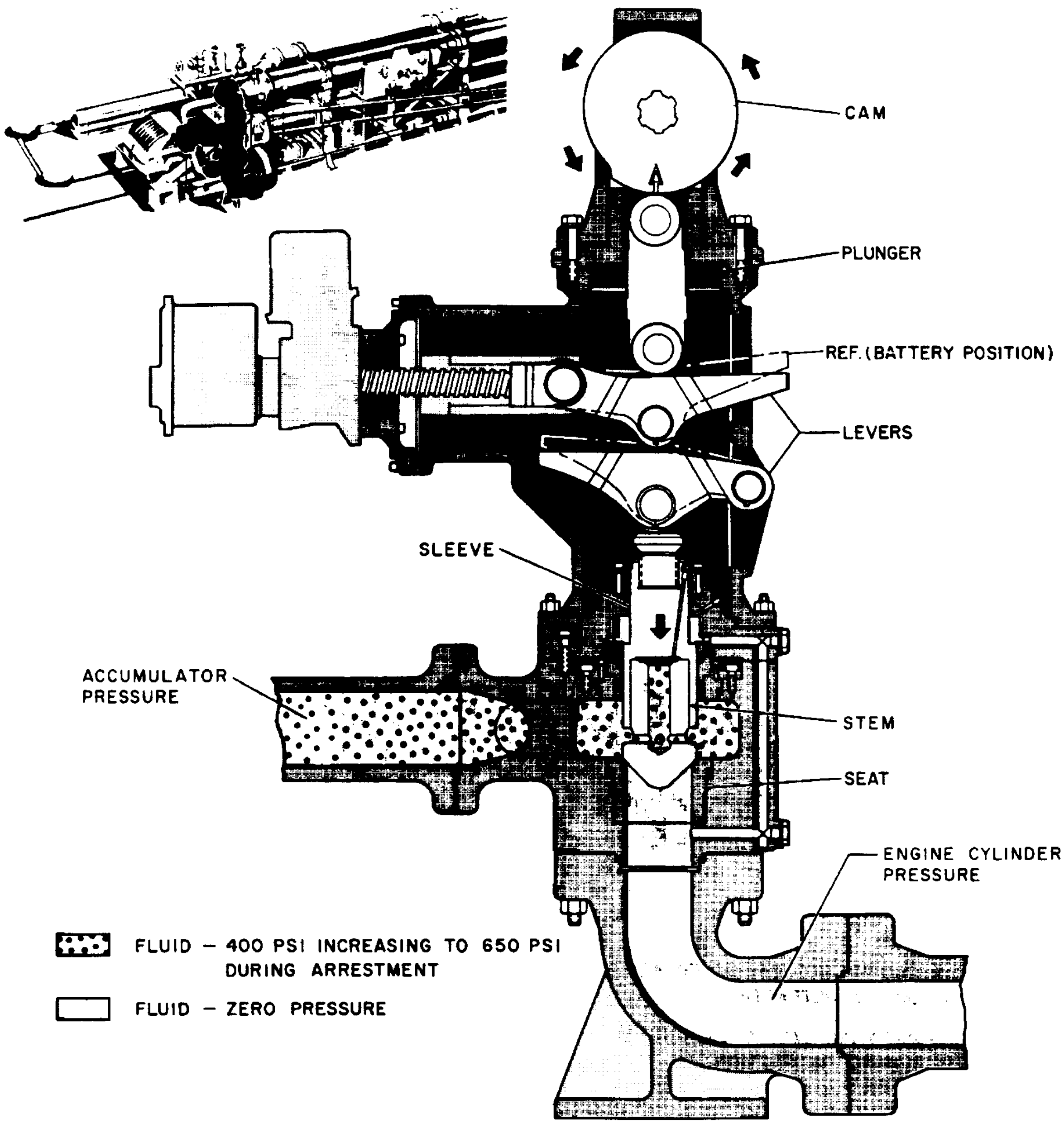


Figure 9-9d Constant Runout Valve Operation

RETRACTION

The control valve stem is held closed by the accumulator pressure during retraction. The control valve drive system rotates the control valve cam toward its "BATTERY" position. As the cam is rotated toward its "BATTERY" position, accumulator pressure forces the valve sleeve and stem to separate. At the completion of retraction, the engine cylinder and accumulator pressures are equalized.

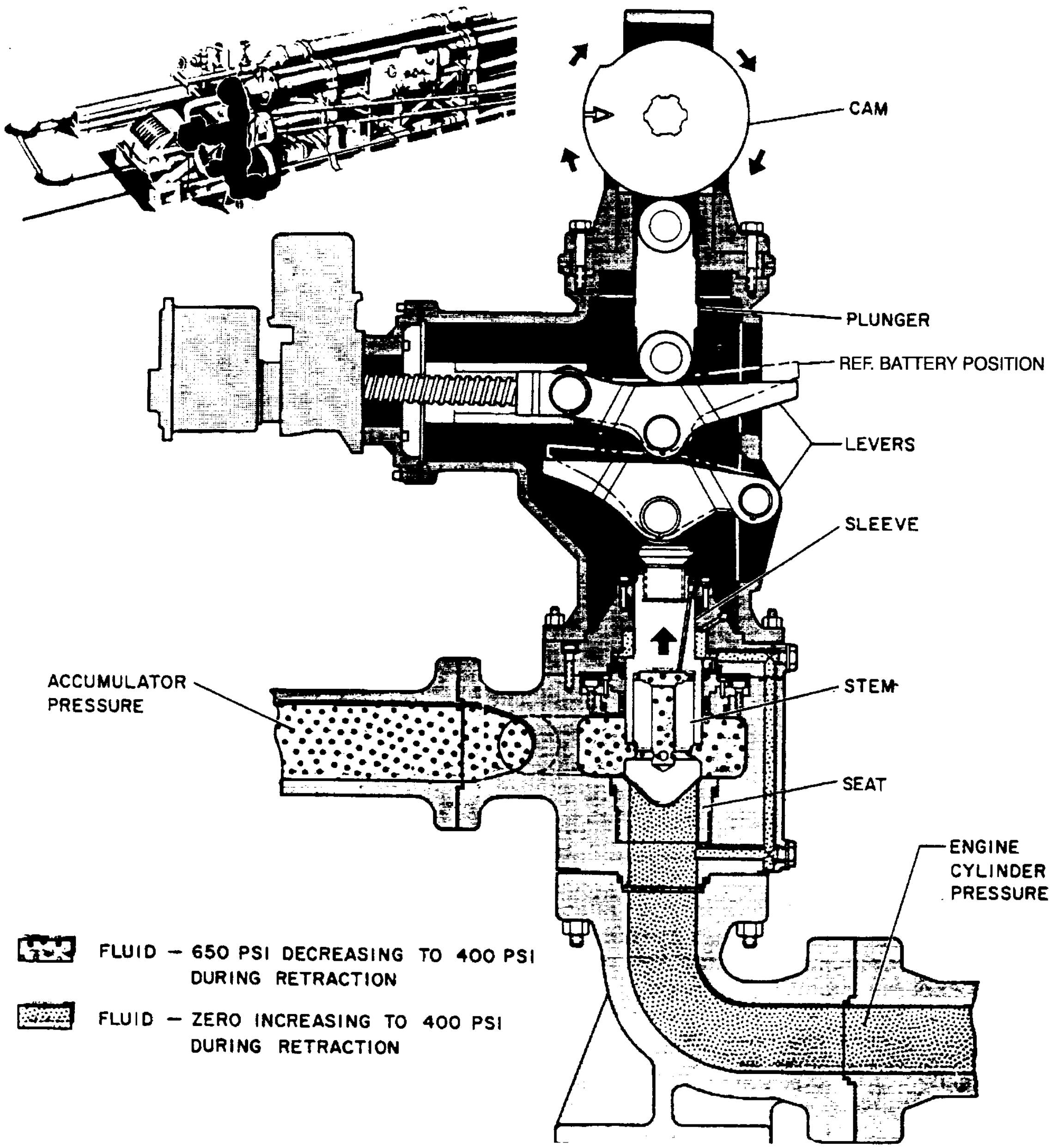


Figure 9-9e Constant Runout control Valve Operation

9.5 CABLE ANCHOR DAMPER

9.5.1 General. Both service use and experiment testing of the Mark 7 Mod 2 and Mod 3 arresting engines demonstrated the need for eliminating the slack which occurred between the engine sheaves and the anchored end of the purchase cable at the beginning of the arrestment. When slack was taken up by the aircraft, severe cable vibrations resulted from the sudden tensioning of the cable. The cable anchor damper removes slack as it occurs, thereby eliminating excessive cable vibrations. The cable anchor dampers are essentially hydraulic shock absorbers and their installation allows the increased landing speeds encountered in operating the latest fleet aircraft. The sudden engagement of the deck pendant by an incoming aircraft creates cable slack. The cable anchor damper installation *(Figure 9-1)* removes the cable slack in the purchase cable system.

The cable anchor damper installation consists of two identical anchor damper assemblies for each arresting engine. Each of which consists of a hydraulic cylinder that is mounted between an operating end head and cushioning end head. They are located either on top of or at the base of the arresting engine. Engine piping connects by way of the retracting valve, with a manifold tee which, in turn, is connected to the operating end head of each cable anchor damper assembly. Each assembly is connected to the purchase cable by a torque release coupling which is secured to a piston rod. The opposite end of the piston rod connects with a piston in the operating end head. Presence of engine cylinder pressure in the operating end head moves the piston into the hydraulic cylinder (away from the anchor damper "Battery" position).

Movement of the piston into the cylinder removes slack which occurs between engine sheaves and cable anchor damper couplings during the beginning of arrestment. When slack is taken up, the piston resists return of the cable, thus keeping it taut and decreasing cable vibrations.

The torque release coupling provides a means for removing built up torque in the purchase cable. Torque build up is caused by cable attempting to unwind when stretched during an arrestment. A limit switch is bolted to the fixed track is tripped when the cable anchor damper assembly reaches its "Battery" position. Each cable anchor damper is equipped with a separate battery-position indicator system and both must indicate "BATTERY" position for the cable anchor damper assemblies prior to an arrestment.

9.5.2 Retraction Valve. The retraction valve assembly returns displaced engine fluid from the engine accumulator back to the engine cylinder after completion of an arrestment. The fluid flow from the accumulator (forced by compressed air) to the engine cylinder forces the crosshead away from the fixed sheaves back to "BATTERY" position. The retracting valve is normally held closed similar to a check valve.

9.6 ENGINE DRIVE SYSTEM

The drive system *(Figure 9-10)* transfers the force of an incoming aircraft to the arresting engine. The drive system consists of the deck pendant, purchase cable, damper sheaves, and various sheave installations.

9.6.1 Deck Pendant. The deck pendants are wire rope cables spanned across the flight deck which are engaged by the arresting hook of an incoming aircraft. They are numbered P-1, P-2, P-3, P-4 from aft to forward.

Deck pendants are made of 1-3/8 inch diameter, 6 x 30 type G, flattened strand construction, preformed, uncoated long lay wire rope with a minimum breaking strength of 188,000 pounds. Each wire rope is made up of 6 steel strands, each of which is a bundle of 12 major and 12 intermediate wires twisted around a triangular core of 3 to 9 wires *(Figure 9-11)*. The strands are twisted about an oiled hemp center core within which is contained a paper or plastic tape strip bearing the name of the wire rope manufacturer. The function of the oiled hemp center is to provide a "cushion" for each strand and also to supply lubrication when the cable is under tension. The deck pendant cable ends are equipped with swaged type terminals. These terminals are pinned to the clevis and socket assembly at the purchase cable coupling for quick detachment during replacement.

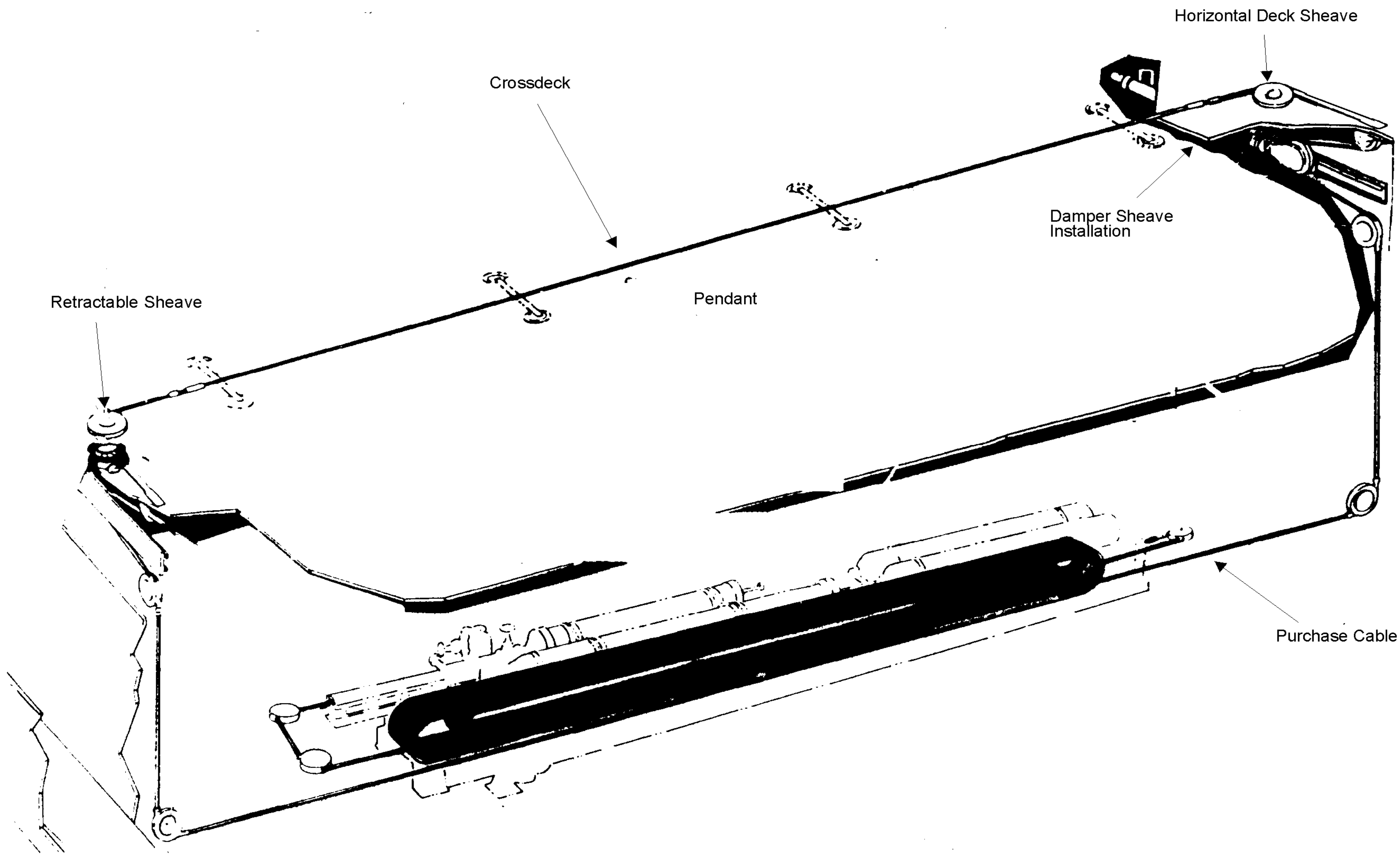


Figure 9-10 Drive System Arrangement

9.6.2 Purchase Cable. The purchase cable is the wire rope reeved onto the arresting engine sheaves and fed through fairlead tubing and over fairlead sheaves to the deck gear on the flight deck. The purchase cable transmits the force of the landing aircraft from the deck gear to the arresting engine.

The purchase cables are 1-7/16 inch diameter, 6 x 25 filler wire construction, right hand lay, lang lay cables with a minimum breaking strength of 195,000 pounds. The 6 x 25 filler wire construction means that the cable is made up of 6 strands with 19 major wires and 6 filler wires per strand. *(Figure 9-11)*. The filler wires provide shape and stability to the strand, with little strength contribution. Lang lay denotes cables in which the wires of the strand and the strand are twisted in the same direction so that the outer wires in the lang lay cables run diagonally across the longitudinal axis of the cables.

The purchase cables are made from high strength, uncoated plow steel. A hemp center, made from resilient, oil-impregnated hemp, serves as a foundation for the strands, keeps the strands evenly spaced, and prevents them from bearing against each other. The hemp center also aids in lubrication of the inner wires. Within the hemp center is buried a paper or plastic strip bearing the name of the manufacturer.

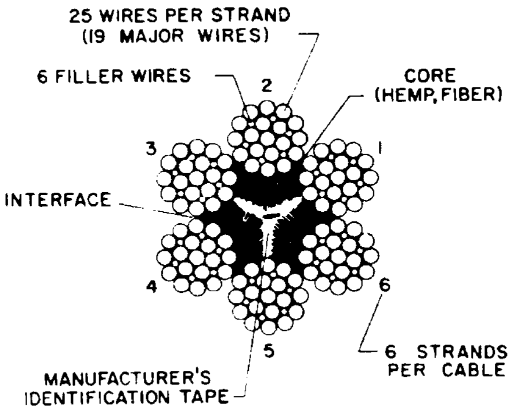
Poured threaded terminals are fitted on each end of the purchase cables. A clevis socket is screwed onto the threaded terminals to connect the purchase cables to the cross deck pendants and to the single reeved engines. *(Figure 9-11)*

9.6.3 Engine Reeving. The Mark 7 arresting engines have an 18 to 1 reeve ratio, which means for every foot of ram travel there are 18 feet of purchase cable payout. The reeve ratio is determined by the number of sheaves on the crosshead.

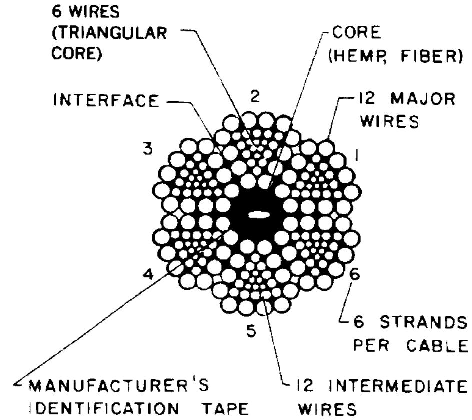
The types of reeves used on the Mark 7 arresting engines are 18 to 1 single reeve on pendant engines, and 18 to 1 endless reeve on barricade engines. The endless reeve barricade engines use only one purchase cable with the two bitter ends terminating on the flight deck and connect to the barricade. The single reeved pendant engines require two purchase cables, one reeved around the 28 inch sheaves and one reeved around the 33 inch sheaves of the fixed sheave and crosshead assemblies. One end of each of the two purchase cables is connected to a torque release coupling on the cable anchor damper operating piston rod on the Mod 3 engines. The opposite ends are connected to the deck pendant. see *Figure 9-12* or illustration of a typical reeving of a pendant and a barricade engine.

9.6.4 Damper Sheaves. High engaging velocities of modern carrier-based aircraft cause excessive cable vibration which is created during any high velocity arrestment. The damper sheave was installed to reduce peak cable tension by damping cable vibrations, paying out cable on demand. Two damper sheave assemblies are installed with each arresting gear unit, one at each side of the landing area immediately below the flight deck *(Figure 9-13)*. An incoming aircraft engages the deck pendant, causing an increase of tension of the purchase cable. The purchase cable is reeved around the sheave damper crosshead in a manner that any increased tension experienced by the purchase cable will cause the sheave damper crosshead to move away from its battery position. As the sheave damper crosshead moves, the damper piston moves, forcing fluid from the cylinder through the fluid manifold, flow control valve, and fluid piping into the accumulator. The resulting pressure buildup in the accumulator will be equal to the purchase cable pull. Retraction of the sheave damper is automatic and occurs when accumulator pressure becomes greater than cable tension as the sheave damper crosshead reaches its battery position, the battery position indicator limit switch is engaged and lights the battery position indicator light at the deckedge.

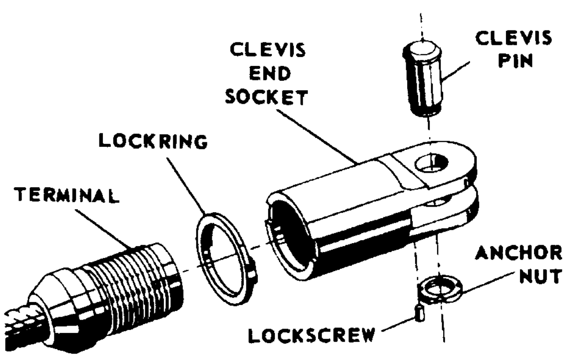
The damper sheaves are essentially a hydraulic shock absorber. Their operational installation in the attack carriers provides for the increased landing speeds encountered in operating the latest fleet aircraft.



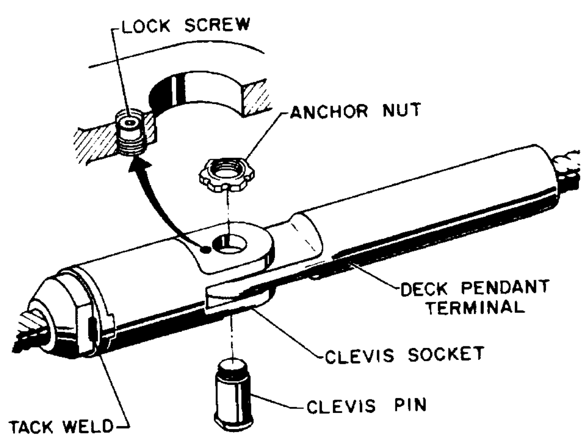
Cross Section of Preformed Purchase Cable 6 x 25



CROSS SECTION OF CROSS DECK PENDANT



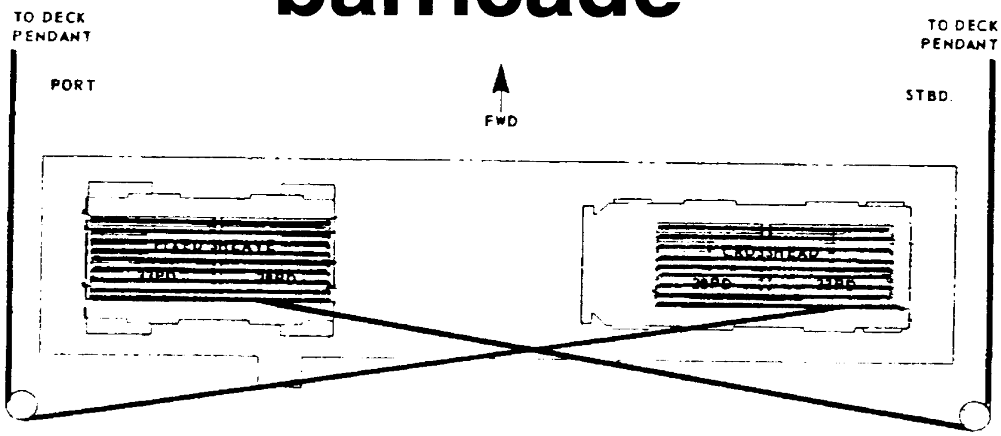
PURCHASE CABLE TERMINAL AND CLEVIS SOCKET ASSEMBLY



PURCHASE CABLE/CROSS DECK PENDANT CONNECTION

Figure 9-11 Purchase Cable/CDP Construction

barricade



pendant

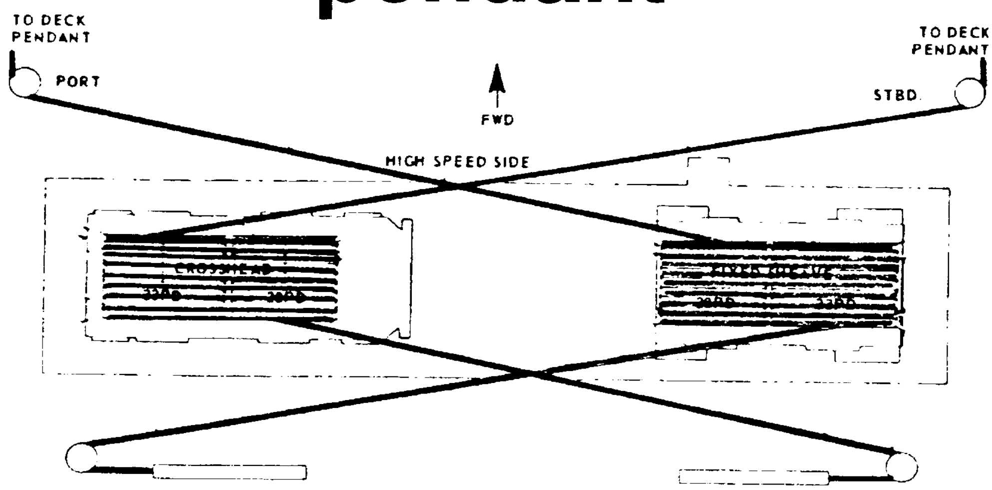


Figure 9-12 Engine Drive System Reeving

ENGAGEMENT

The incoming aircraft engages the deck pendant. The increased tension of the purchase cable moves the damper sheave crosshead from its "BATTERY" position. The damper piston moves with the damper sheave crosshead. Damper piston movement forces fluid into damping accumulator until the resulting pressure build up is equal to the purchase cable pull.

LEGEND

AIR } HIGH PRESSURE (3000 PSI CHARGING)

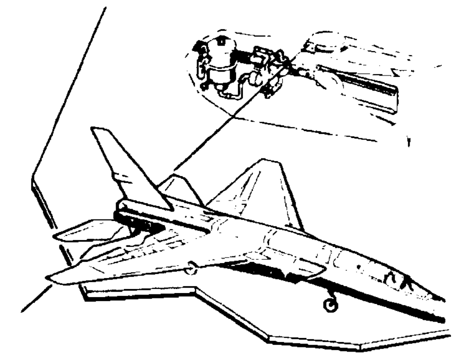
FLUID } HIGH PRESSURE (750 PSI INCREASING TO 3000 PSI DURING STROKE)

AIR, FLUID } INTERMEDIATE PRESSURE (750 PSI INCREASING TO 1500 PSI DURING STROKE)

AIR, FLUID } ZERO PRESSURE

OPEN VALVE

CLOSED VALVE



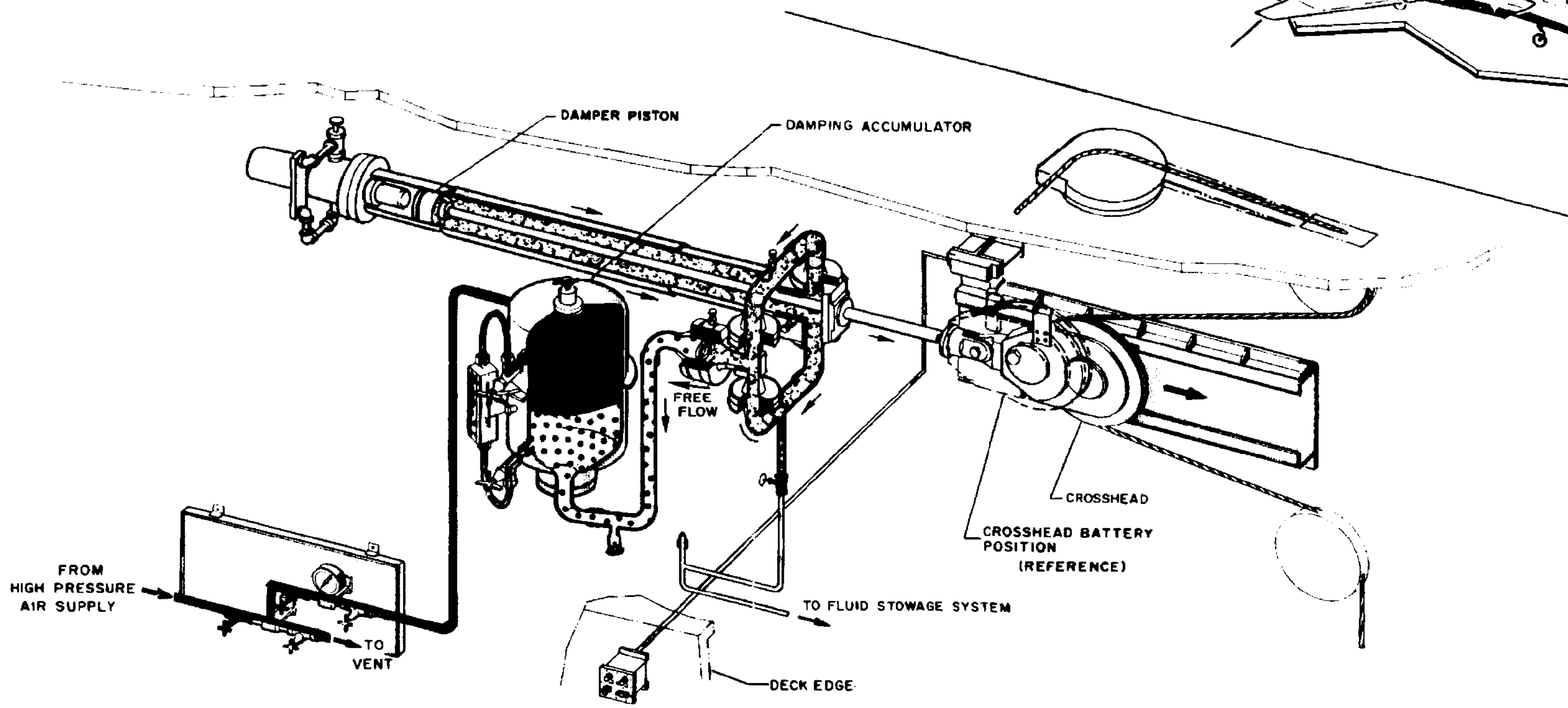


Figure 9-13 Damper Sheave Fluid Flow

9.7 DECK GEAR

The function of the deck gear (*Figure 9-14*) is to provide a means of engaging a landing aircraft and directing the force of arrestment to the arresting engine. The deck gear consists essentially of deck pendants, wire supports, fairlead and deck sheaves, and the barricade system. The deck gear is a series of devices (used for engagement of landing aircraft) which direct and control the energies developed during arrestment.

9.7.1 Recovery Equipment Controls. The aircraft recovery equipment controls *(Figure 9-15)* are grouped in three areas: engine room, deck edge, and pri-fly stations. Synchro receivers for monitoring the settings are provided at all three stations. However the following functions can only be accomplished from the deckedge station:

1. Monitor, raise and lower retractable sheaves.

2. Raise and lower wire supports and barricade stanchion.

3. Retract arresting engines.

9.7.2 Wire Support System. The function of the wire support system is to provide a method of raising the deck pendants off the flight deck to the height required so that they may be picked up by the tailhook of a landing aircraft. A typical wire support installation is shown in *Figure 9-16*.

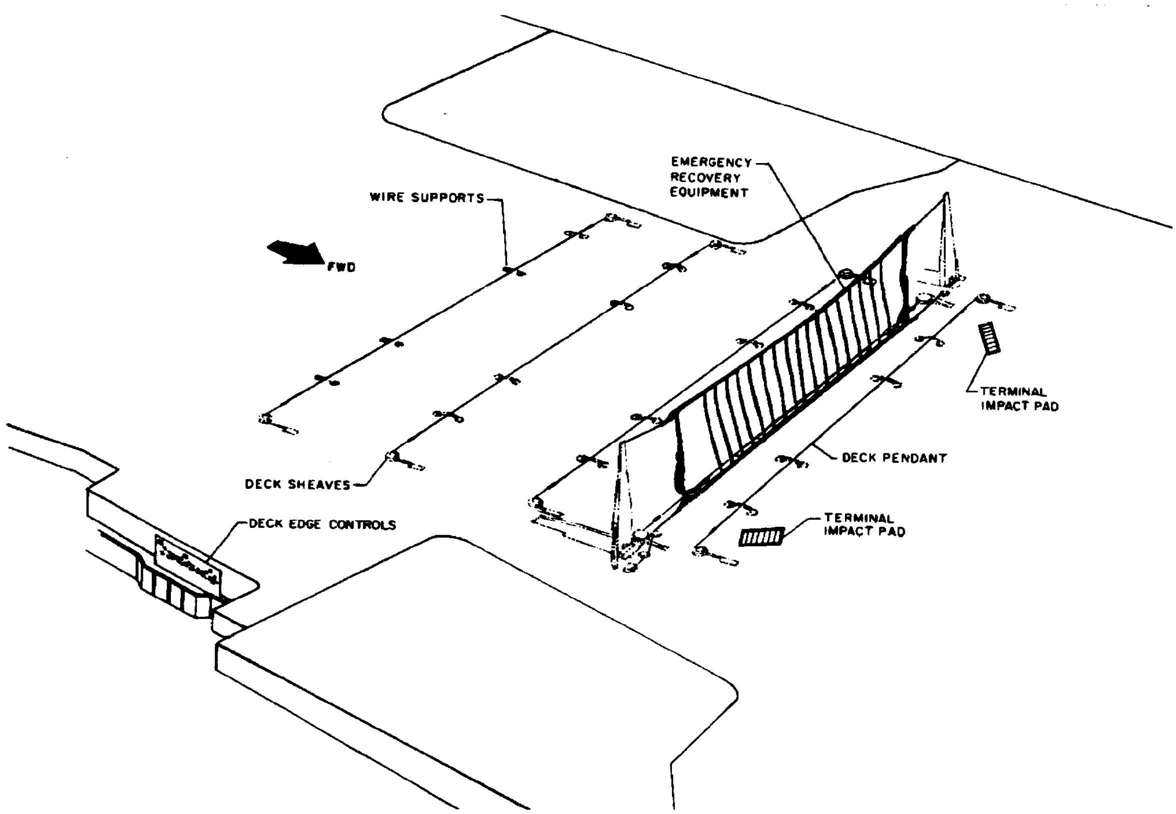
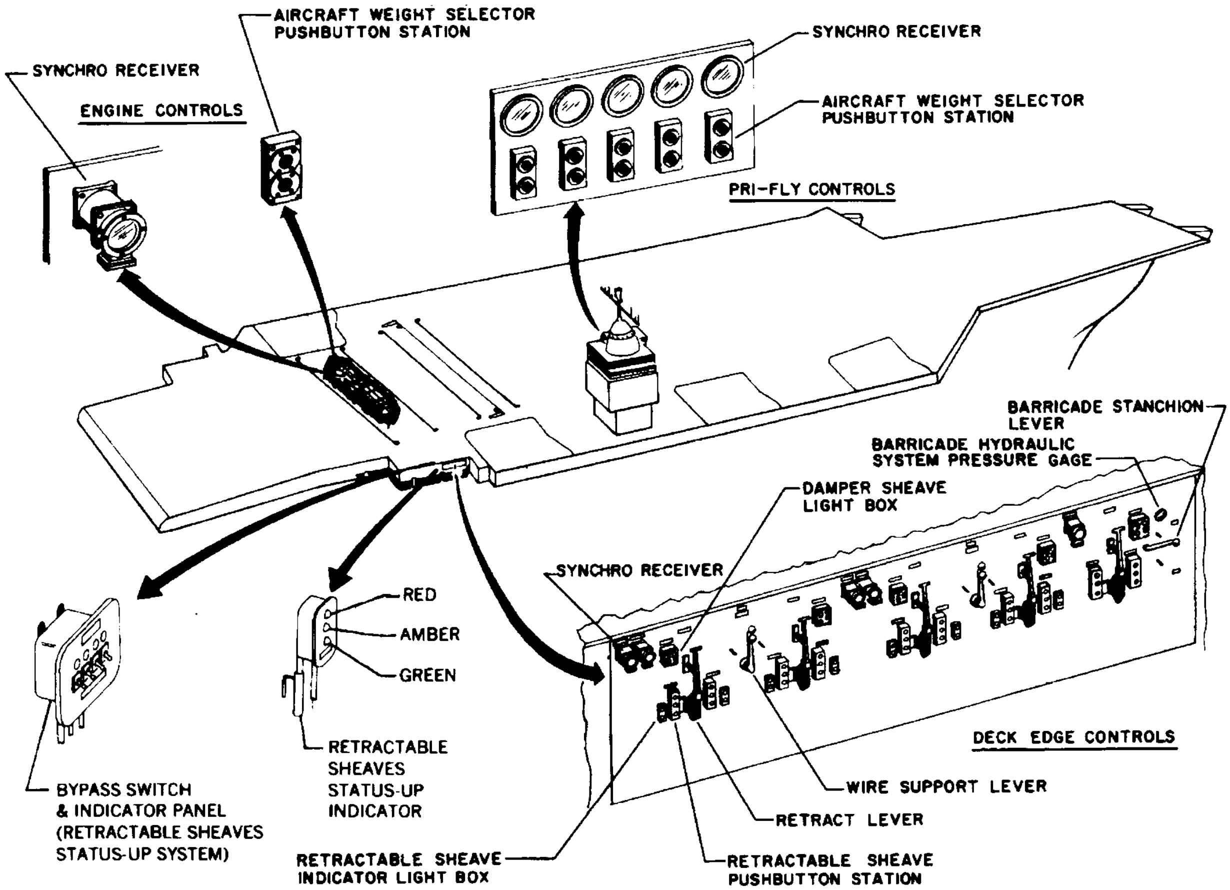


Figure 9-14 Deck Gear Arrangement



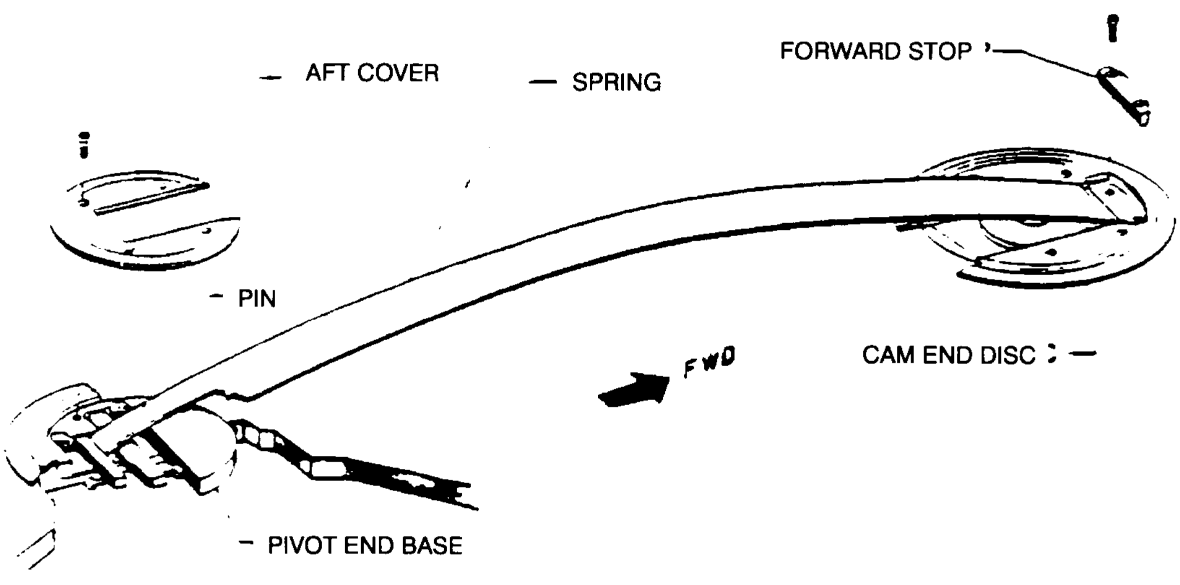


Figure 9-16 Wire Supports

The wire supports are merely curved steel leaf springs that are secured into mounts in the flight deck. The leaf springs can flex to allow an aircraft to taxi over the installed deck pendant. The leaf spring directly supports the deck pendants. The aft pivot end of each spring is provided with a forward and aft stop which can be adjusted to regulate the height of the leaf spring. The leaf springs must be adjusted to provide a minimum height of two (2) inches and a maximum of five one half (52) inches.

9.7.3 Fairlead System Sheaves. There are four types of sheaves used in Mk 7 arresting gear. These are the horizontal deck sheave, the vertical through-deck sheave, the fairlead sheave, and the retractable sheave. All these sheaves are designed to accommodate 1 - 7/16 inch diameter purchase cable and are made of forged aluminum alloy. The fairlead sheaves are used to guide the purchase cable from the arresting engine through the damper sheave. The retractable sheave installation is composed of a through deck sheave and retractable sheave.

Fairlead tubing of two one half (22) inch diameter is installed whenever necessary between fairlead sheaves. This is to protect the purchase cable and to prevent any dangerous whipping in the event of purchase cable breaking. The purchase of all fairlead sheaves is to change the direction of the purchase cable so that it can be led from the arresting engine to the flight deck.

9.7.4 Retractable Sheave. The function of a retractable sheave is to provide a means of lowering deck sheaves which would interfere with the passage of aircraft and deck equipment when in the raised operating position. *Figure 9-17* is example of retractable installation.

Each retractable sheave is operated by an electric motor unit controlled by a deck pushbutton station. In addition, an indicator light box is installed adjacent to the deckedge pushbutton station to show the position of the sheave - a green light when the sheave is fully raised, or a red light in all positions other than fully raised. The retractable sheaves may also be operated by handwheels in case of emergency. The handwheel is located below decks on the operating unit. To eliminate the chance of the retractable sheave being lowered inadvertently during landing operations, the handwheel is removed from the unit whenever it is not actually being used.

It is important that the deckedge operator knows whether the retractable sheave is in the raised position during landing operations. During night operations, visual sighting of the retractable sheave is imperative.

An arresting gear SHEAVE-UP and BY-PASS switch indicator panel is located aft of the arresting gear deckedge control station to indicate the retractable sheave status. The panel is wired into the CLEAR/FOUL DECK light and will prevent the arresting gear officer from giving a clear signal if one or more of the retractable sheaves is not in the fully-up position.

If a retractable sheave cannot be raised, the arresting gear officer directs that the affected deck pendant be removed from the deck. A CLEAR DECK signal can now be activated by closing the respective by-pass switch and thus over-riding the shutdown arresting gear engine. The by-pass condition is visually indicated by an amber warning light on the BY-PASS SWITCH and INDICATOR panel. In addition, a three lamp, deckedge indicator panel with red, amber, and green lenses, mounted aft of the deckedge control station, will indicate the retractable sheave status. This panel will illuminate red when any of the retractable sheaves are down and green when all sheaves are up. In case one or more arresting engines and retractable sheaves are bypassed, the deckedge indicator light will display green and amber lights.

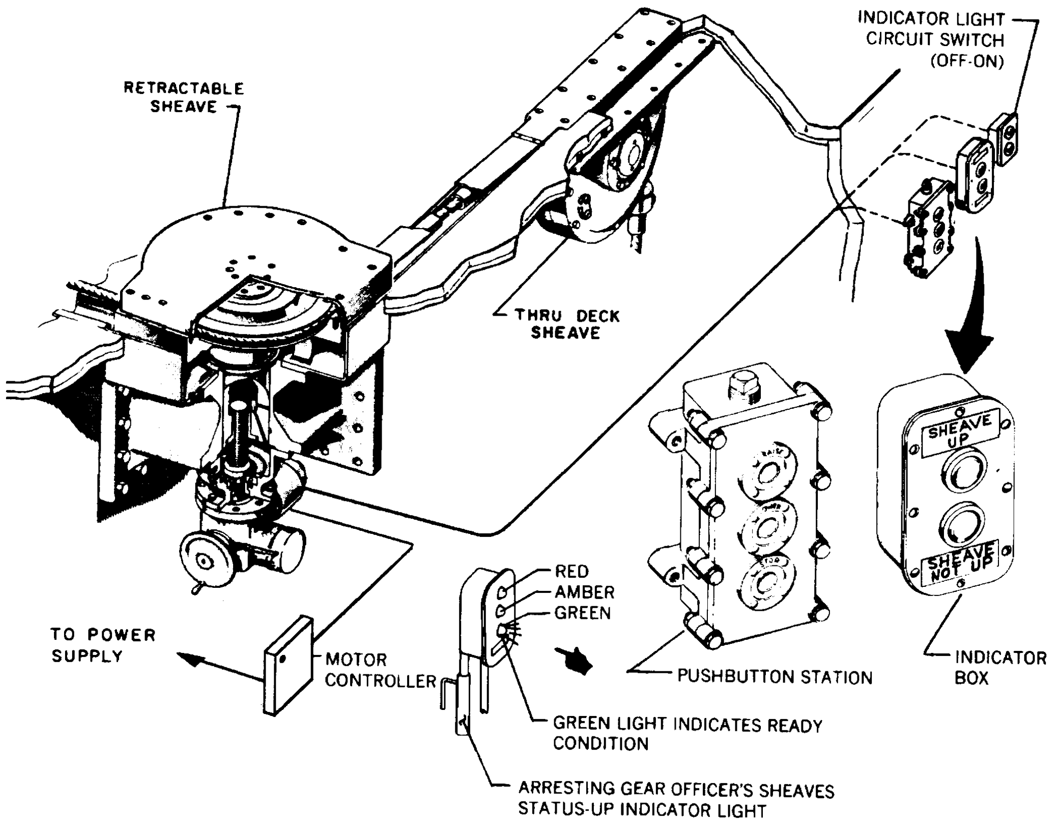


Figure 9-17 Retractable Sheave Installation

9.8 EMERGENCY RECOVERY EQUIPMENT (BARRICADE)

The emergency recovery equipment (barricade) *(Figures 9-4 and 5)* are used only when a normal (pendant) arrestment cannot be make. The barricade system includes the following basic items or parts: barricade webbing, stanchions winches, tensioning pendants, multiple release assemblies, and parallel pendant.

9.8.1 Barricade Webbing. The barricade webbing assembly *(Figure 9-18)* consists of three main webbing assemblies, each webbing assembly consist of five webbing systems. Each webbing system in turn is composed of upper and lower horizontal athwart ship loading straps joined to each other at the ends by link assemblies. The equalizing segment of each loading strap is attached to a connecting strap. Five vertical engaging straps, spaced 20 feet apart, are connected to each upper and lower load strap by means of a sliding fittings. the 20 foot spacing between the vertical straps on each webbing systems affords equalized loading of the components in that particular system by permitting only one vertical strap to engage an aircraft's wing. One webbing assembly, which is five such webbing systems combined, affects equalizing loading every four feet along the wings' leading edges due to the ultimate staggering arrangement of the vertical straps.

The "Standard" barricade webbing assemblies arrive as single webbing assemblies that must be made into "triple" barricades prior to use. A standard assembled "triple" barricade is required to be in a "ready" status for an emergency arrestment during all recoveries. A barricade can be used only three times for barricade "drills" before becoming a "training only" barricade. When a barricade becomes a "training" barricade, a new "ready" barricade must be assembled.*(Figure 9-19)*

Care must be taken when moving the "ready' barricade from its storage sight for inspections or drying purposes. 30 to 35% of a barricade's strength can be lost in only four such movements if the barricade is allowed to drag across the non-skid deck. Also 100 or more hours of direct sun light on the webbing assembly will render it useless for a "ready" barricade.

The effect of water on the barricade are temporary. When wet the webbing assembly loses about 10 to 15% percent of its strength and increases in weight. However, when the webbing assembly is dry to the touch, the barricade returns to its prior strength and weight.

The barricade webbing assemblies are stored in an area were they are readily accessible when an emergency situation arises. The area is dry and protects the webbing assemblies from direct sun light.

9.8.2 Multiple Release Assembly. The multiple release assemblies *(Figure 9-18)* provide the connection between the upper and lower load straps of the barricade and the tensioning pendants of the barricade stanchions. They serve to release the webbing during an aircraft engagement.

The multiple release assembly consists of a number of release straps. Each strap is attached to one of the tension loops of the loading straps by means of a "girth hitch" and a modified release assembly which is secured to the tensioning pendants by quick release pins.

9.8.3 Parallel Pendant. The parallel pendant is incorporated on barricades to reduce the excessive barricade loading imposed by the arresting engine during barricade arrestment. A ring type coupling is used to connect the barricade webbing assemblies and the parallel pendant to the extension pendant, which, in turn, is connected to the purchase cable.

The ring type coupling is connected to the equalizing segments of the loading straps by use of extension loops. The ends of the extension loops are passed through the large hole of the ring type coupling which is an integral part of the webbing assembly. The ends are then joined by use of connector link assemblies (*Figure 9-20*).

9.8.4 Barricade Engines. The engines used for barricade arrestment are identical to those used for deck pendant arrestment with four exceptions:

1. No fluid coolers are installed;
2. Barricade engines are endless reeved;
3. No cable anchors are installed since cable anchors are not needed for endless reeve;
4. A short stroke control valve is used.

9.8.5 Barricade Stanchion and Controls
The barricade stanchion and controls (*Figure 9-21*) provides a means of raising and lowering the barricade webbing assembly. The stanchions are raised and lowered by hydraulic power supplied by the power package.

9.8.5.1 Stanchion Installation. Barricade stanchions house the winches which tension and support the barricades. They further provide the structure on which the barricade is raised or lowered.

Except for differences of location and position of the actuating apparatus-deckedge, above or below deck-port and starboard stanchions are identical. The port stanchions with their actuating apparatus are described in this chapter. Barricade stanchions are described in the chapter. Barricade stanchions (*Figure 9-22*) are welded steel, tray-shaped assemblies that consist essentially of a base on which is hinged to the frame. Each barricade frame contains the winches, sheaves, and the pendants used to tension the upper barricade webbing load strap. Each barricade stanchion is provided with a slot, at the top of the inboard side, through which passes the upper tensioning pendant. The frame moves as a hinge around the two stanchion shafts, the barrel of the hinge being the base and the knuckles of the hinge being the hubs of the stanchion frame. The two shafts act as the pins of the hinge. The actuating arm is keyed and pinned on the outer shaft and is pinned to a holder on the stanchion. Rubber bumper pads are bolted in the deck recess to cushion the shock of lowering the stanchions.

9.8.5.2 Winches. The deck and stanchion winches (*Figure 9-22*), through the tensioning pendants, provide a means of tensioning the lower and upper (respectively) loading straps of the barricade webbing.

9.8.5.3 Power Package. The barricade power package is used to raise and lower the barricade stanchions (*Figure 9-21*). To raise stanchions, the deck latches are manually unlocked and the deck edge control lever is rotated to the "BARRICADE UP" position. Movement of the control lever permits medium pressure hydraulic fluid, from the barricade accumulator, to flow through the barricade deck edge control valve to both stanchion cylinders. The hydraulic fluid forces the piston rod into the cylinder which, supplemented by the counter-balancing spring, raises the stanchion to "UP" position. The low pressure hydraulic fluid on the lowering end of the piston is forced from the cylinder to the stowage tank. The motor controller actuates the pump in conjunction with the barricade accumulator pressure switch. The controller is supplied with a selector switch with "OFF" "AUTOMATIC" and "RUN" positions. When the motor controller selector switch is set at "AUTOMATIC" and the pressure in the accumulator drops below 1250 psi the electric pump motor is energized. Hydraulic fluid is dumped from the stowage tank into the accumulator until accumulator pressure reaches 1500 psi and the pump automatically cuts off.

The power package accumulator does not contain sufficient fluid to raise and lower the stanchions more than three times without the pump operating. Approximately 20 minutes is required for the pump to replenish fluid to the operating level in the accumulator, if stanchions are cycled three times without the pump operating. The READY CONDITION for normal operation specifies 1,500 psi accumulator pressure; however, stanchions will raise and lower, taking a longer period of time with a lower pressure, as is experienced if stanchions are cycled without the pump operating. Pressure at the start of the third cycle will be approximately 850 psi without the pump operating.

The counterbalancing spring (*Figure 9-21*) supplements the force of the stanchion cylinder in raising the stanchion and cushions the contact of the stanchion with the deck.

9.8.5.4 Controls. Raising and lowering of the barricade is controlled by a valve (*Figure 9-21*) operated at the deckedge station. Valve positions are "RAISE", "NEUTRAL" (midposition), and "LOWER." The neutral position is used for standby position. It blocks all valve ports, and any passage of fluid is stopped when the valve is in this position. It blocks all valve ports, and any passage of fluid is stopped when the valve is in this position. This position should be used to stop stanchions during raising or lowering or to hold the stanchions either up or down.

WARNING

If a pendant engagement is intended and the engine is inadvertently left set for a barricade engagement and an engagement is made, and since the runout will be shorter than the normal pendant runout, the cable loads will increase by approximately 10% for heavy weight aircraft. This occurrence is not disastrous, if not on a continuing basis.

WARNING

If the barricade is erected on the deck and the engine is inadvertently set for pendant arrestment and a barricade arrestment is made, the engine will allow more runout than that normally programmed for a barricade arrestment. This additional runout, plus the exact distance used up by the "slack-takeup" and deployment of the webbing, would require a runout distance that is either marginal or not available on the carrier, with possible disastrous consequences i.e., the aircraft could go off the angle.

Thus, a more reasonable approach would be to keep both engines set in "pendant" condition, since conversion to a barricade condition should not delay the entire barricade rigging time, after some training in the procedures.

WARNING

Installations rigged to engines #3 and #3A (deck locations P3 and P3A, respectively), must be used as alternates to each other, not used at the same time. When one position is rigged (either as a pendant or as a barricade), the other position must not be rigged.

The possibility of a double-wire engagement due to the close proximity of P3 and P3A (4'3") and the disastrous effects upon the aircraft hook, makes his arrangement prohibited.

9.8.6 Improved-Type (Semi-coated) Barricade. A new, improved semi-coated barricade has been designed to be more reliable, easier to handle, and quicker to assemble and install than the standard barricade. It is intended to replace the present standard type (uncoated) barricade on an attritional basis only when stock levels deplete. Features of the improved-type barricade include:

1. Factory attached breakaway release straps in lieu of manually installed straps at installation.
2. Elimination of connecting straps and attached D-rings.
3. Redesign of engaging straps, to resist cutting.
4. Elimination of engaging strap D-ring.
5. Replacement of closed type release fitting and attaching fasteners with open, snap-type hooks.
6. Elimination of extension pendants.
7. All nylon tie-down straps incorporated in lieu of elastic strap clips.
8. Polyurethane coated "rolled edges" on loading straps.
9. Open mouth U-shackle in lieu of closed mouth ring coupling.
10. One piece extension loops (combines extension loop and connecting strap into one).
11. Elimination of connector fittings on loading straps.
12. Polyester parallel pendant in lieu of deck cable type parallel pendant.
13. Velcro-type boot assemblies in lieu of metal zippered boot assemblies.
14. Nine total semi-coated webbing systems versus 15 uncoated webbing systems.

General procedures, inspections/replacement criteria, etc. remain essentially unchanged from those of the standard type barricade.

NOTE

The E-2/C-2 barricade has not been changed.

Figures 9-23 and *9-24* show the typical improved semi-coated barricade installation and highlight many of the fundamental changes.

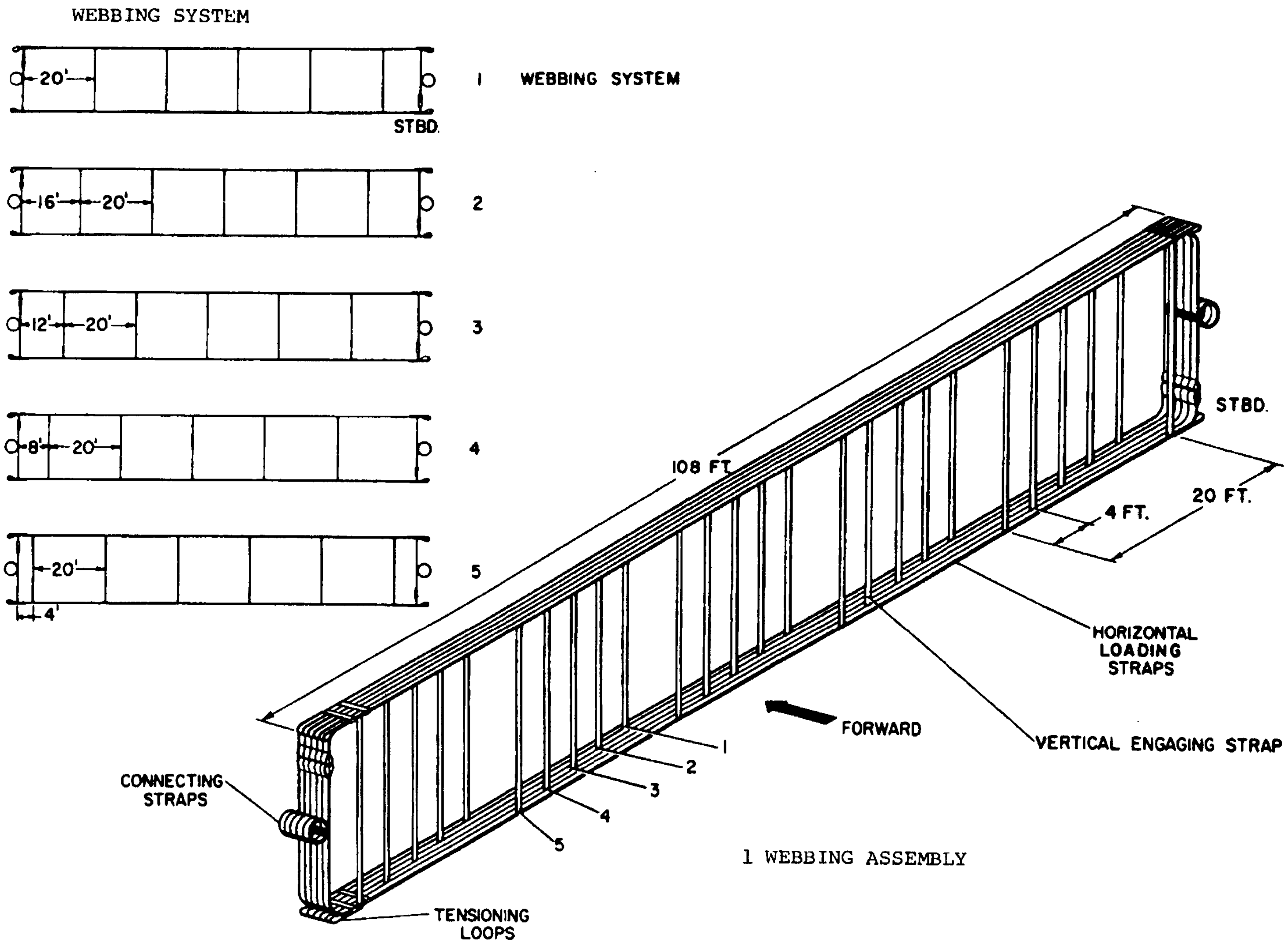


Figure 9-18 Schematic of Barricade Single Webbing Assembly (1 of 2)

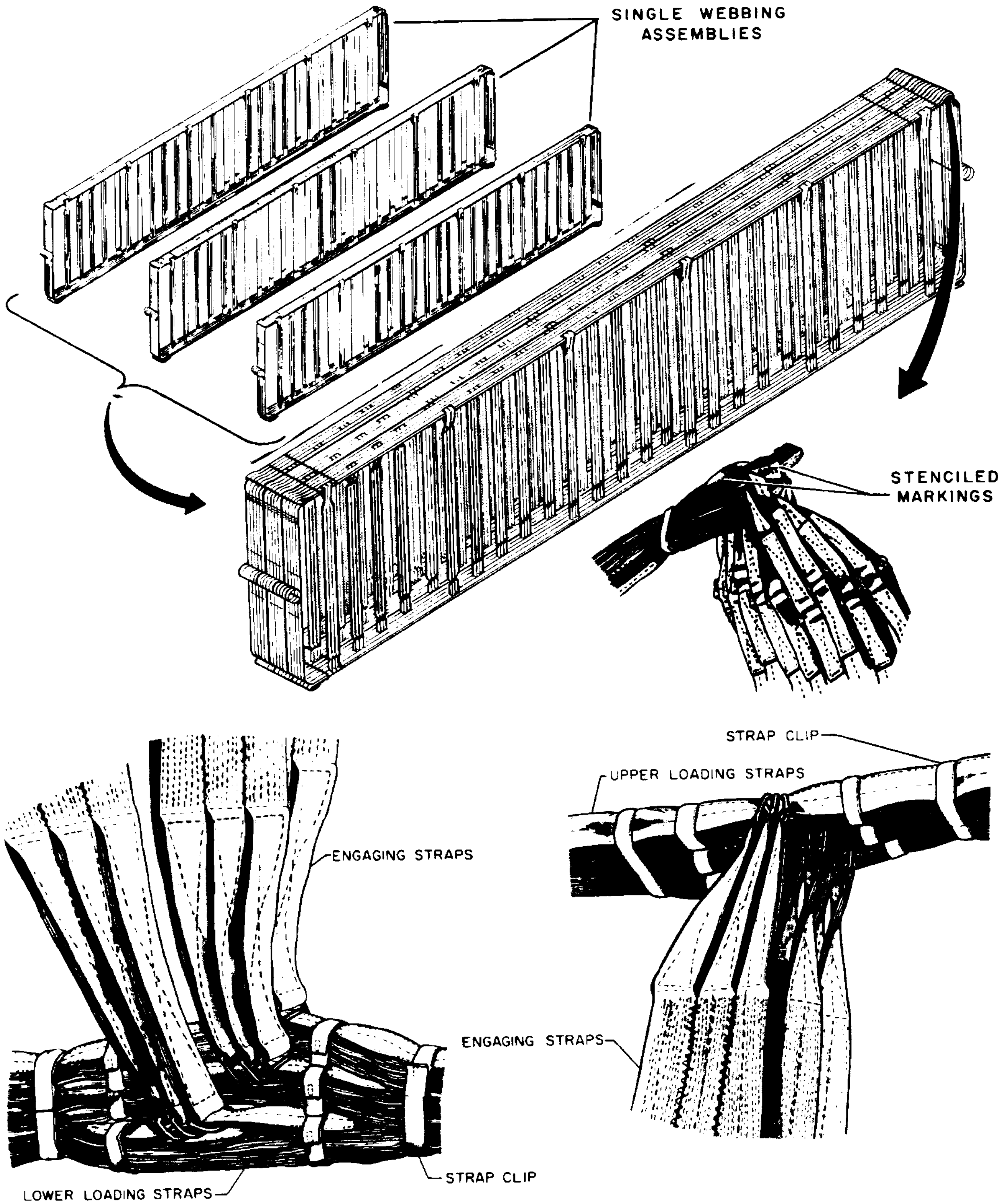


Figure 9-18 Schematic of Barricade Single Webbing Assembly (2 of 2)

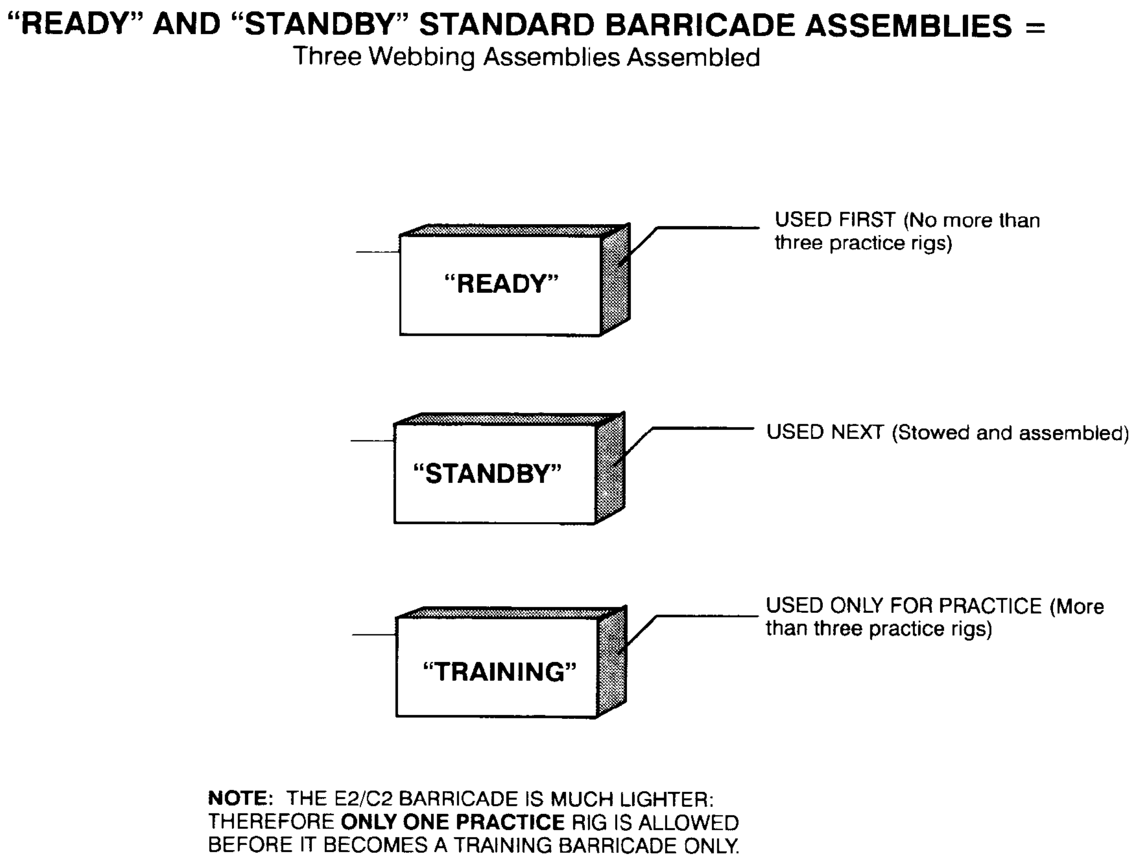


Figure 9-19 "Ready" and "Standby" Barricade Status

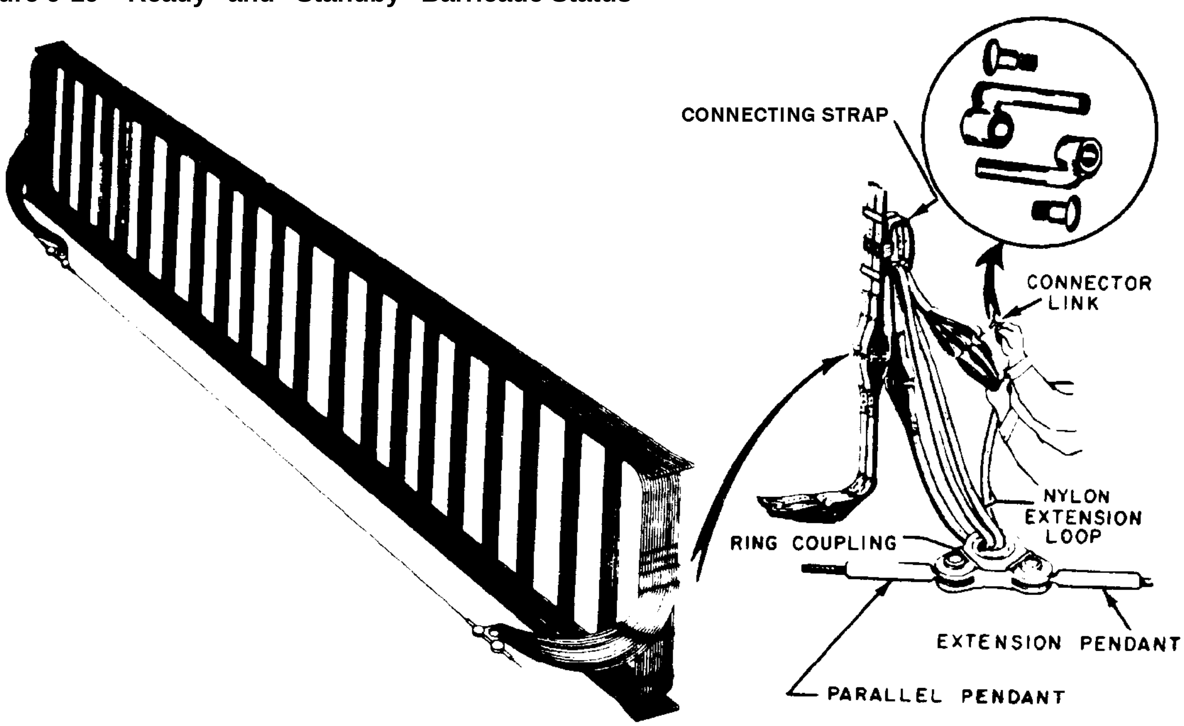


Figure 9-20 Connector Link Installation

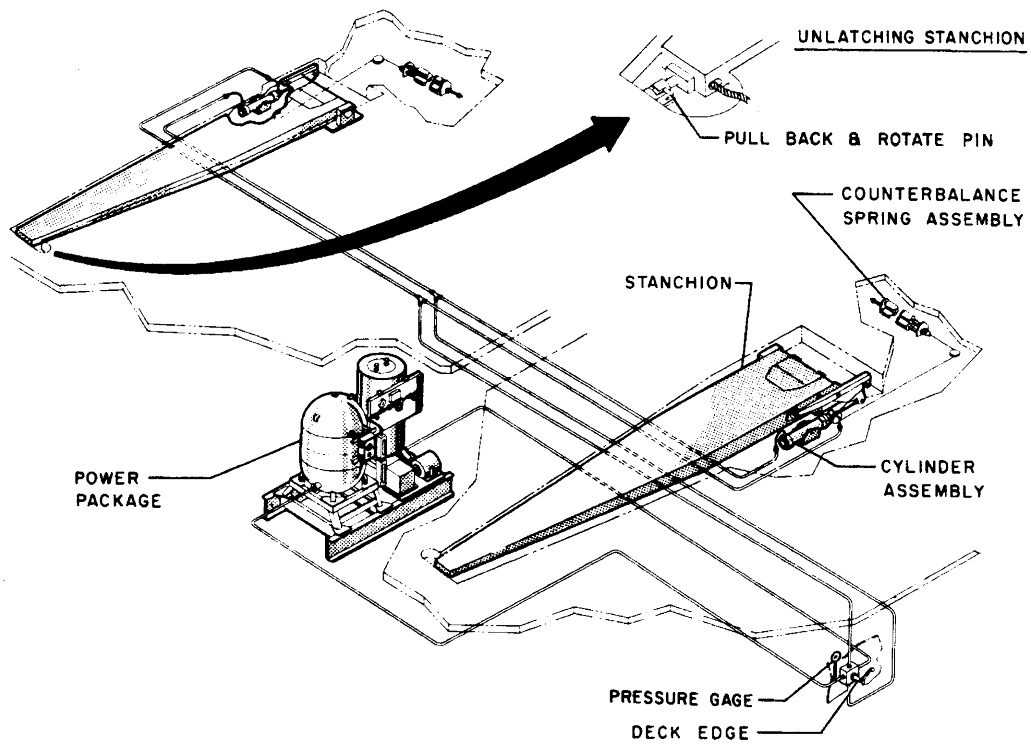


Figure 9-21 Barricade Stanchion and Controls

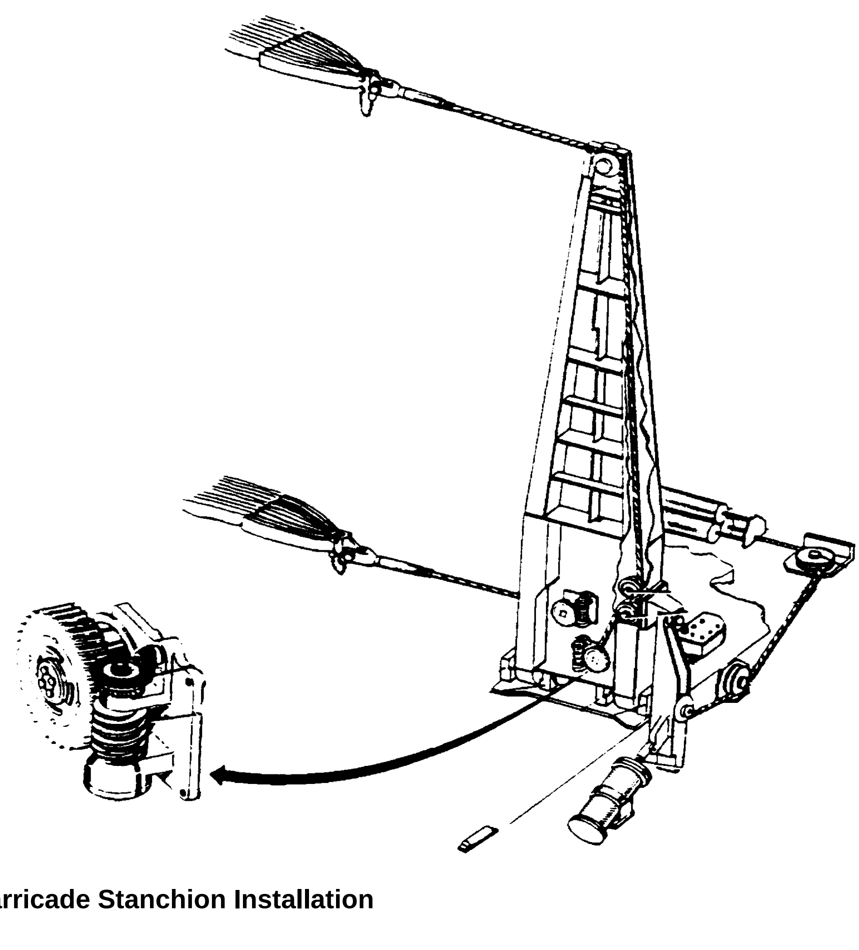


Figure 9-22 Barricade Stanchion Installation

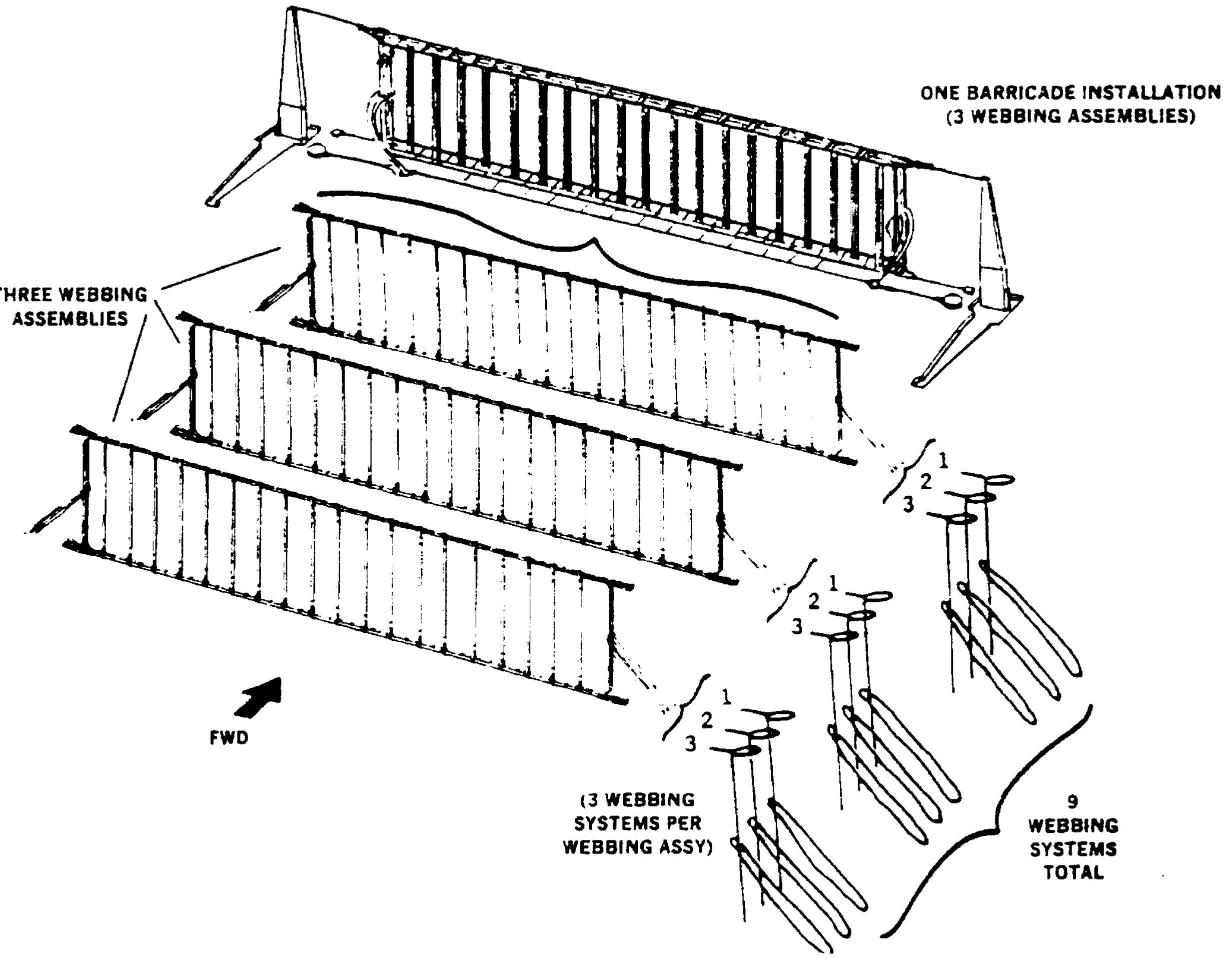


Figure 9-23 Improved type (Semicoated) Barricade Installation

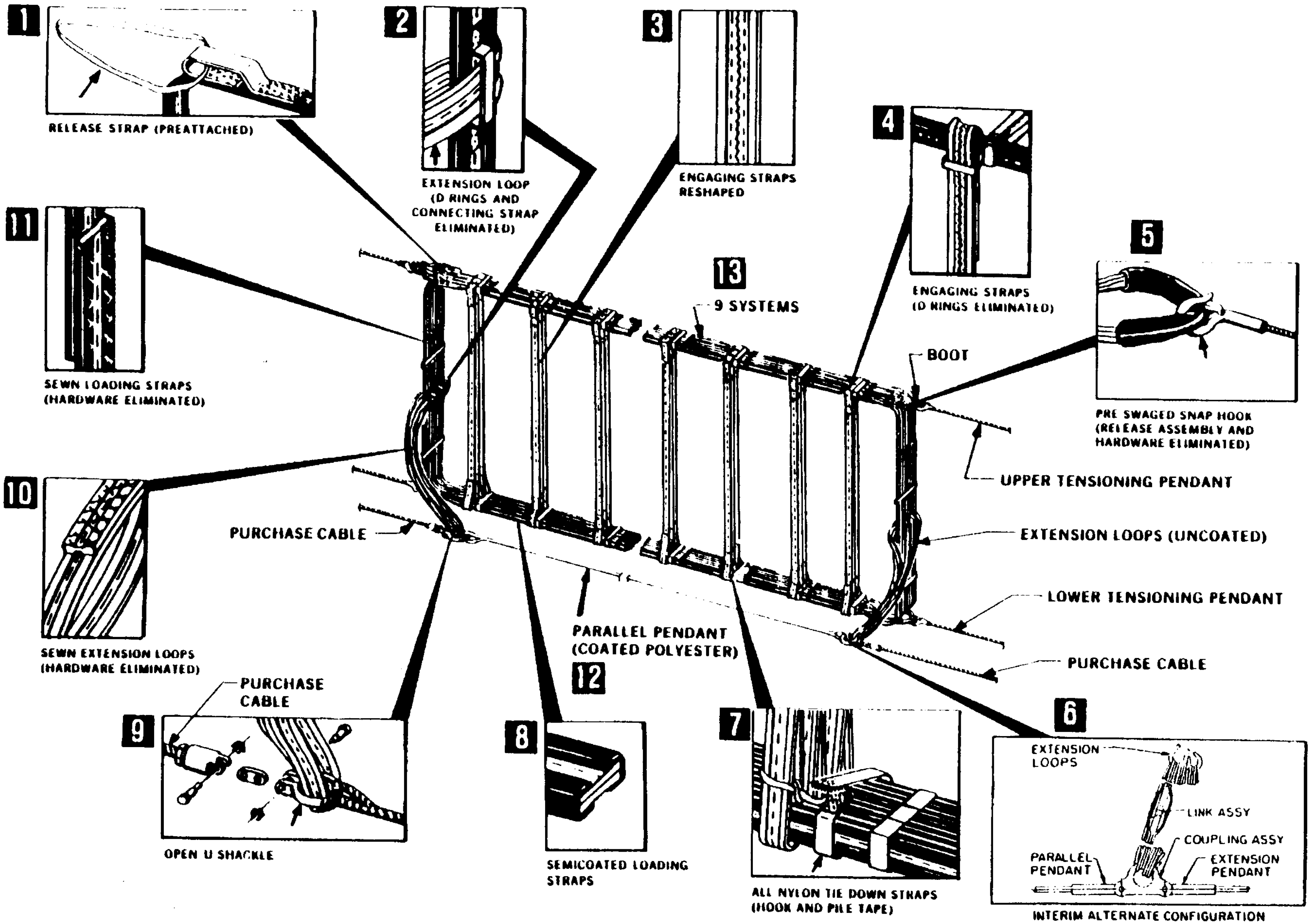


Figure 9-24 Improved-type Shipboard Barricade Installation

CHAPTER 10

STEAM CATAPULTS

10.1 General

The purpose of the steam catapult is to provide a means to safely launch aircraft from carrier decks, day or night, in almost any kind of weather. The steam catapult is designed to launch aircraft with the ship headed into the wind, but has the capabilities to launch aircraft downwind, alongside the pier, or at anchor.

10.2 CAPABILITIES

C-13-0: 74,000 lbs. at 128 knots in 249 ft. Track length: 264 ft. 10" (CV-63, CV-64, CVN-65, CV-67 {3 of 4})

C-13-1: 80,000 lbs. at 140 knots in 309 ft. Track length: 324 ft. 10" (CV-67 {1}, CVN-68, CVN-69, CVN-70, CVN-71)

C-13-2: 80,000 lbs. at 140 knots in 309 ft. Track length: 324 ft. 10" (CVN-72, CVN-73, CVN-74, CVN-75, CVN-76)

NOTE

Primary difference between C-13-1 and C-13-2 is that -2 has 21" diameter power cylinders vice 18".

10.3 CATAPULT SYSTEMS

Each catapult consists of eight major systems:

1. Launching Engine System
2. Steam System
3. Retraction Engine System
4. Drive System
5. Hydraulic System
6. Bridle Tension System
7. Lubrication System
8. Control System

10.3.1 Launching Engine System. The Launching Engine System launches the aircraft, the other seven systems support the launching engine by providing or controlling a functions required for the launching engine to operate properly and efficiently.

The launching engine *(Figure 10-1)* consists of the cylinders, cylinder covers, piston assemblies, sealing strip, grab, shuttle and trough covers. The engine is powered by steam from the ships boilers which is allowed to enter the aft end of the launching engine through the launching valve. This steam then acts on the piston assemblies and projects them forward at an ever accelerating rate. By means of the shuttle assembly, an aircraft can be connected to the catapult hereby projecting it forward as the catapult is fired. At the forward end of the catapult is the water brake assembly which halts the forward motion of the catapult. At this time the aircraft is released from the shuttle with sufficient speed to become airborne.

A most critical factor of the launching engine is that it must be pre-heated to the proper temperature to ensure safe and efficient operation. Installed in the catapult trough is the external preheating system for the launching engine. Finned tubing lies underneath the power cylinders on both sides and in the middle, supplied with steam from the ships boilers, to ensure proper heating of the launching engine prior to operation. Thermal expansion then allows the launching engine cylinders to elongate to the proper operating distance of 7" both rows of cylinders within 1" of each other, to meet the proper operational requirements.

The water brake assembly *(Figure 10-2)*, provides the catapults braking capability. With the forward end of the catapult launching engine cylinders telescoped over the 9 ft. water brake cylinder, the steam piston and spear assembly (middle), is guided forward though the cylinders and halted at the forward end of the catapult by the water brake installation. When the catapult is fired, the spear on the forward part of the piston assembly's guided into the mouth of the water brake cylinder where water pressure resists its entering thereby providing a braking action for the catapult. The water brake cylinder is supplied with fresh water from a 5,000 gallon tank, located directly below decks in the water brake pump room. This is a recirculating system which eliminates excessive use of fresh water.

The piston and spear assembly *(Figure 10-3)*, moves forward and aft inside the launching engine cylinders, one assembly in each row of power cylinders. As the assembly moves in either direction a steam seal called the sealing strip is lifted from its seat on the cylinder cover and placed back down on its seat by means of the guide and connector on the piston assembly. This action ensures minimum loss of steam pressure during operation. A cylinder cover seal is also mounted on top of the steam piston which prevents steam from escaping over the top of the piston and slowing the forward motion of the piston and spear assembly.

The shuttle assembly *(Figure 10-4)* provides a means of interconnecting both piston and spear assemblies to an aircraft located above the launching engine installation. Numerous teeth (dogs) are located on the shuttle frame and each piston and spear assembly connector to enable both pistons to be connected directly to the shuttle assembly.

Depending upon the type of catapult, cylinder elongation indicator installation varies. Some installations are as shown in *Figure 10-5* with the scale and indicator pointer below decks in the launching valve compartment and others are viewed from the flight deck at the forward end of the catapult track.

10.3.2 Steam System. The steam system of the catapult, is a wet receiver system *(Figure 10-6)*. This installation enables the catapult to operate with a constant steam pressure. The receiver is filled with water and superheated steam from the ships boilers. With the proper level of water, at the correct operating temperature the wet receiver system allows the catapult a constant acceleration when fired by the action of the steam and water within the steam receiver.

Also shown in *Figure 10-6* are the rotary type launching valves. Their function is to allow steam into the launching engine cylinders. The rotary type valve rotates to open allowing steam into the cylinders firing the catapult.

10.3.3 Retraction Engine System/Drive System. The retraction engine system provides a means of retrieving the shuttle and piston assemblies after the catapult has been fired. The retraction engine also provides the ability to position the shuttle assembly at any point along the catapult track for maintenance purposes or preoperation and postoperation inspections.

The current type of retraction engine in use is the rotary retraction engine *(Figure 10-7)*. This installation is hydraulically operated and works in conjunction with the drive system *(Figure 10-8)* to position the shuttle and spear assembly at any point along the catapult track. As hydraulic fluid enters the manifold assembly it is directed to a drive motor through a series of directional valves. This fluid pressure then rotates the motor in whichever direction desired to drive the grab assembly forward or aft. The hydraulic motor rotates a drum which feeds cable onto and off simultaneously. The cables are guided on and off of the drum by a traverse carriage assembly which is geared to the drum and motor.

The cables are tensioned through means of cable tensioners mounted on the engine which are hydraulically operated and ensure that the proper cable tension is maintained throughout the system during operation. Four separate cables are utilized on the retraction engine, varying in length, two on the aft side of the grab assembly, which are the retract cables and two on the forward side which are the advance cables. These cables are reeved into the system and anchored at one end to the grab and the other end to the retraction engine.

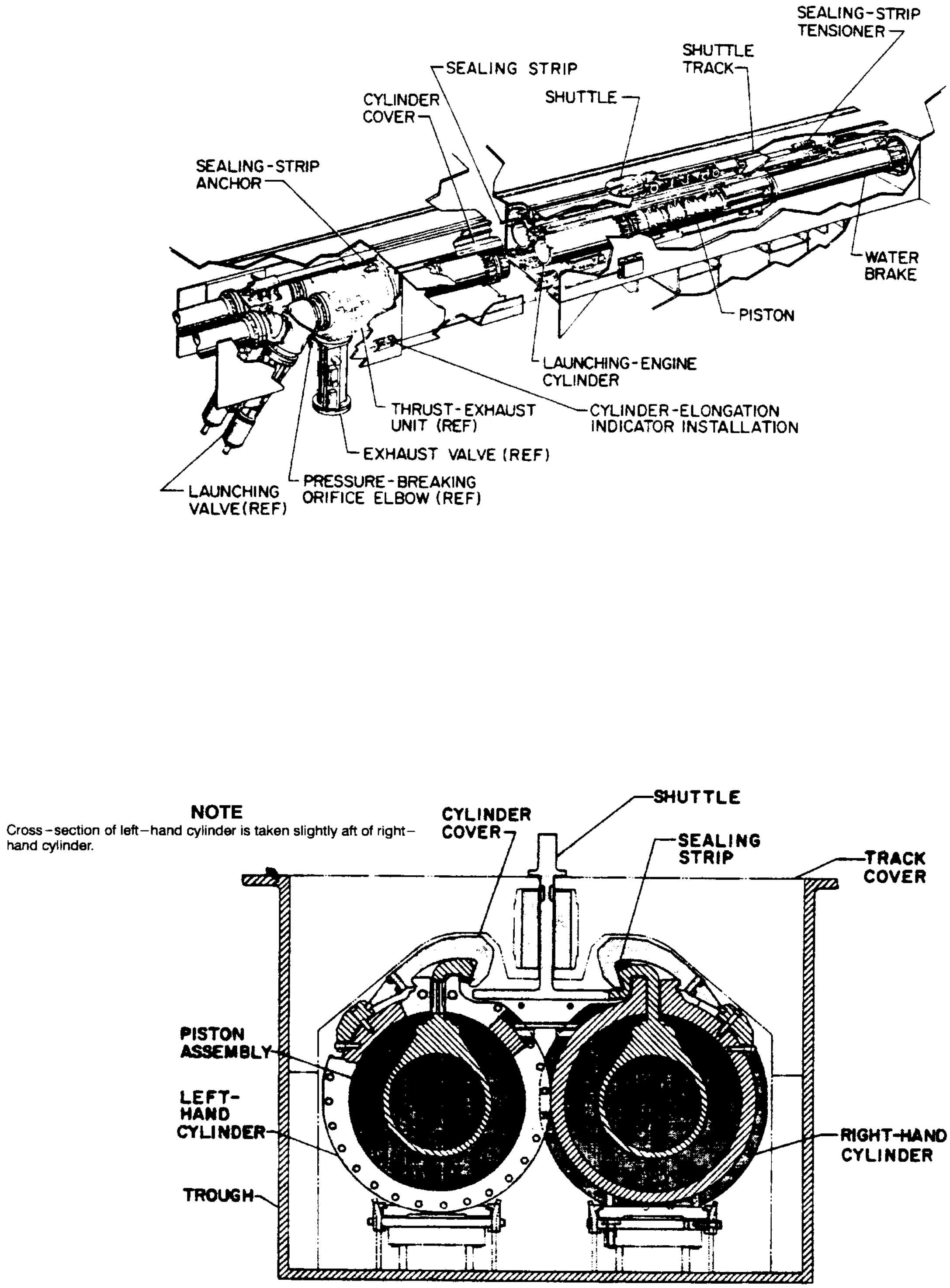


Figure 10-1 the Launching Engine System

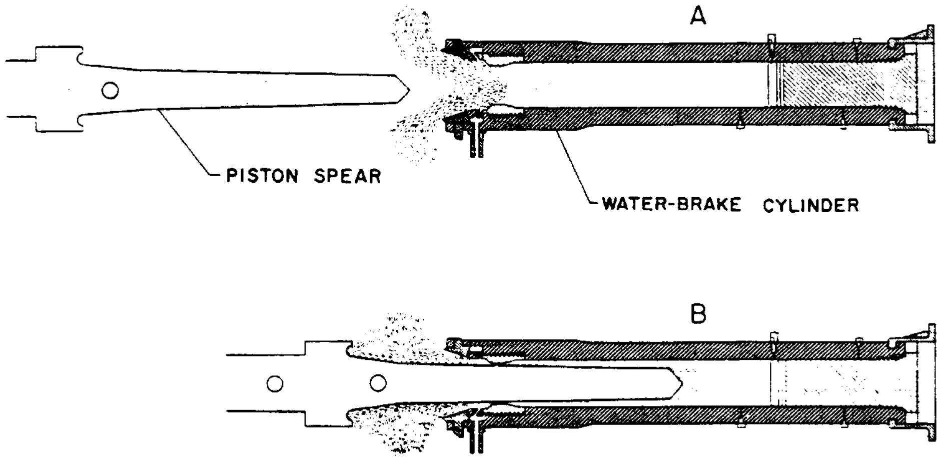


Figure 10-2 Water Brake Assembly

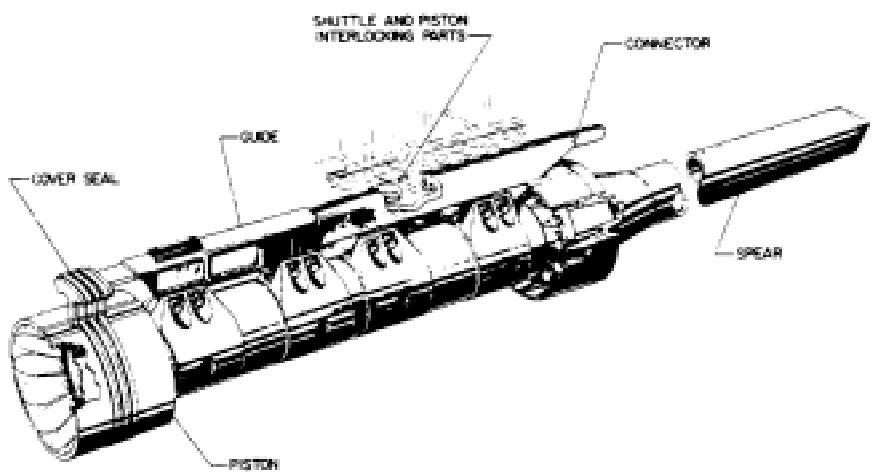


Figure 10-3 Piston and Spear Assembly

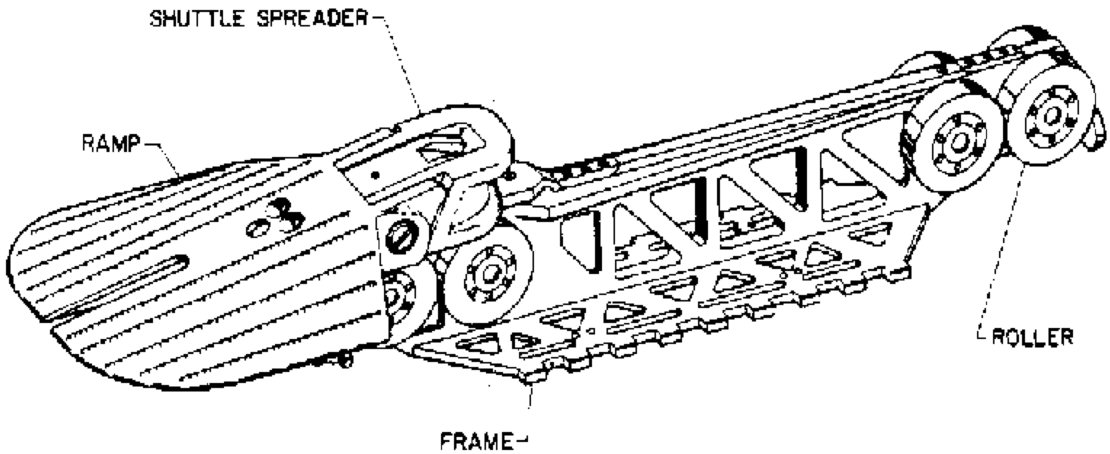


Figure 10-5 Shuttle Assembly

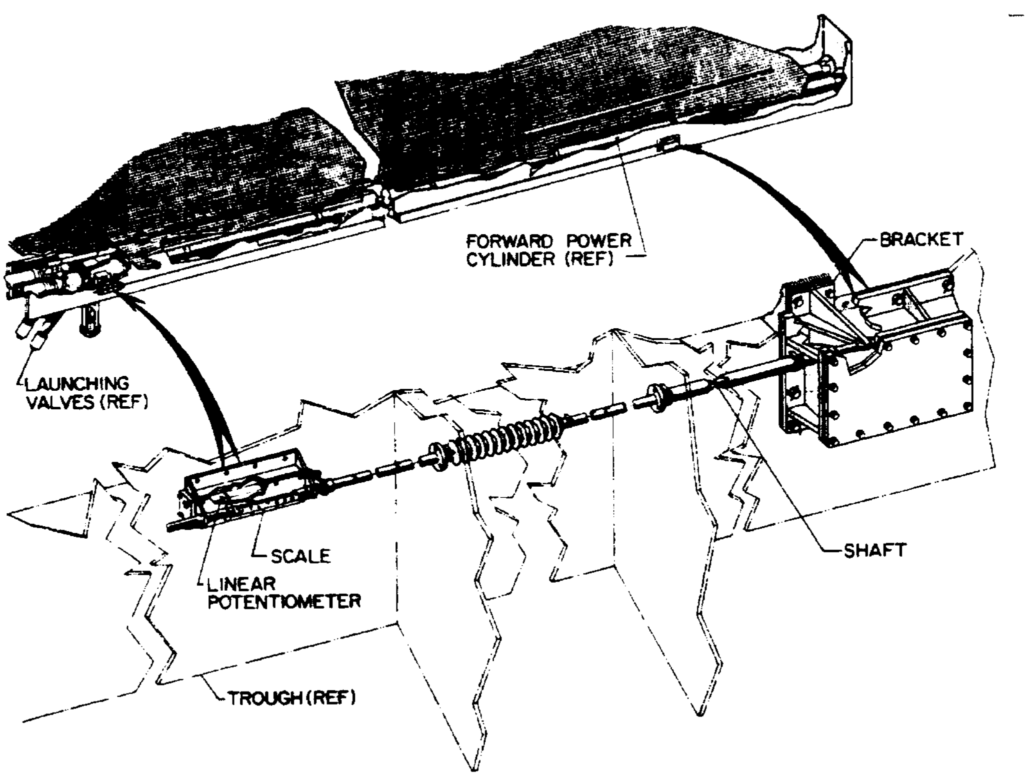


Figure 10-5 Cylinder Elongation Indicator Installation

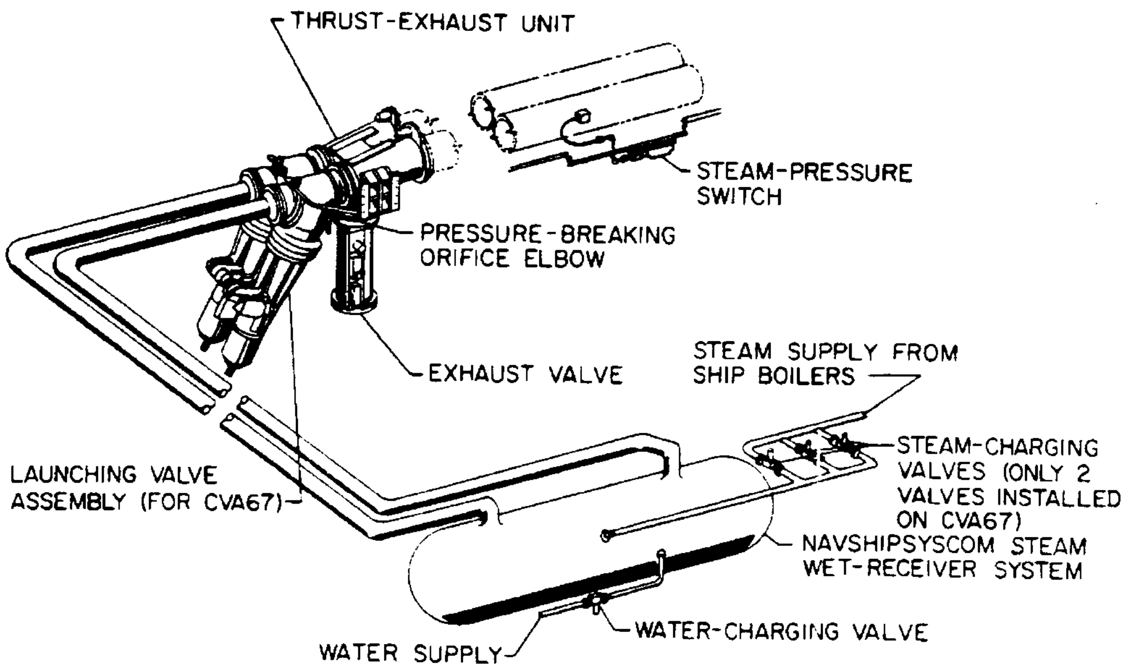


Figure 10-6 Catapult Steam System

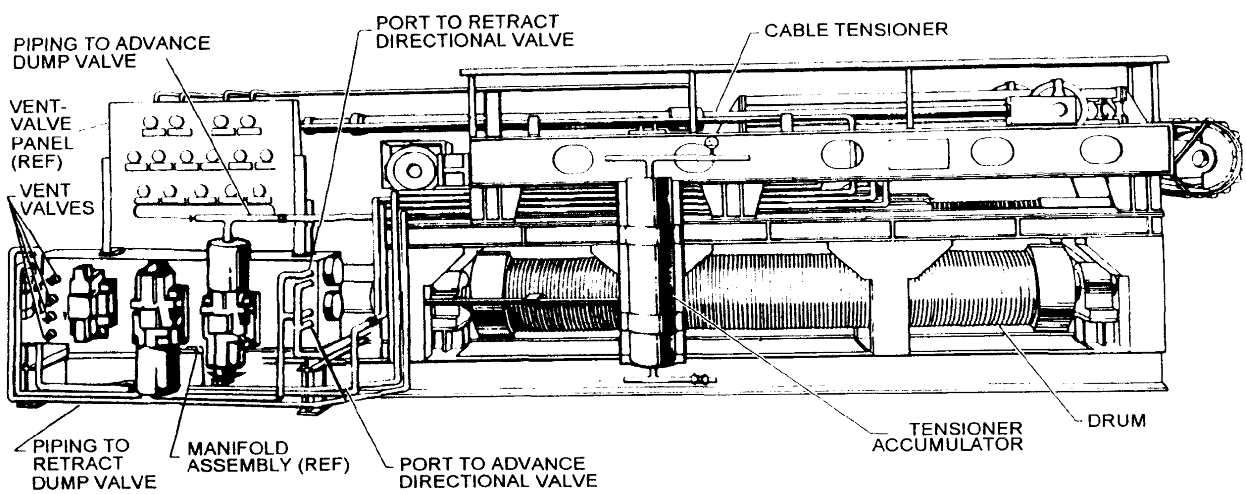


Figure 10-7 Rotary Type Retraction Engine

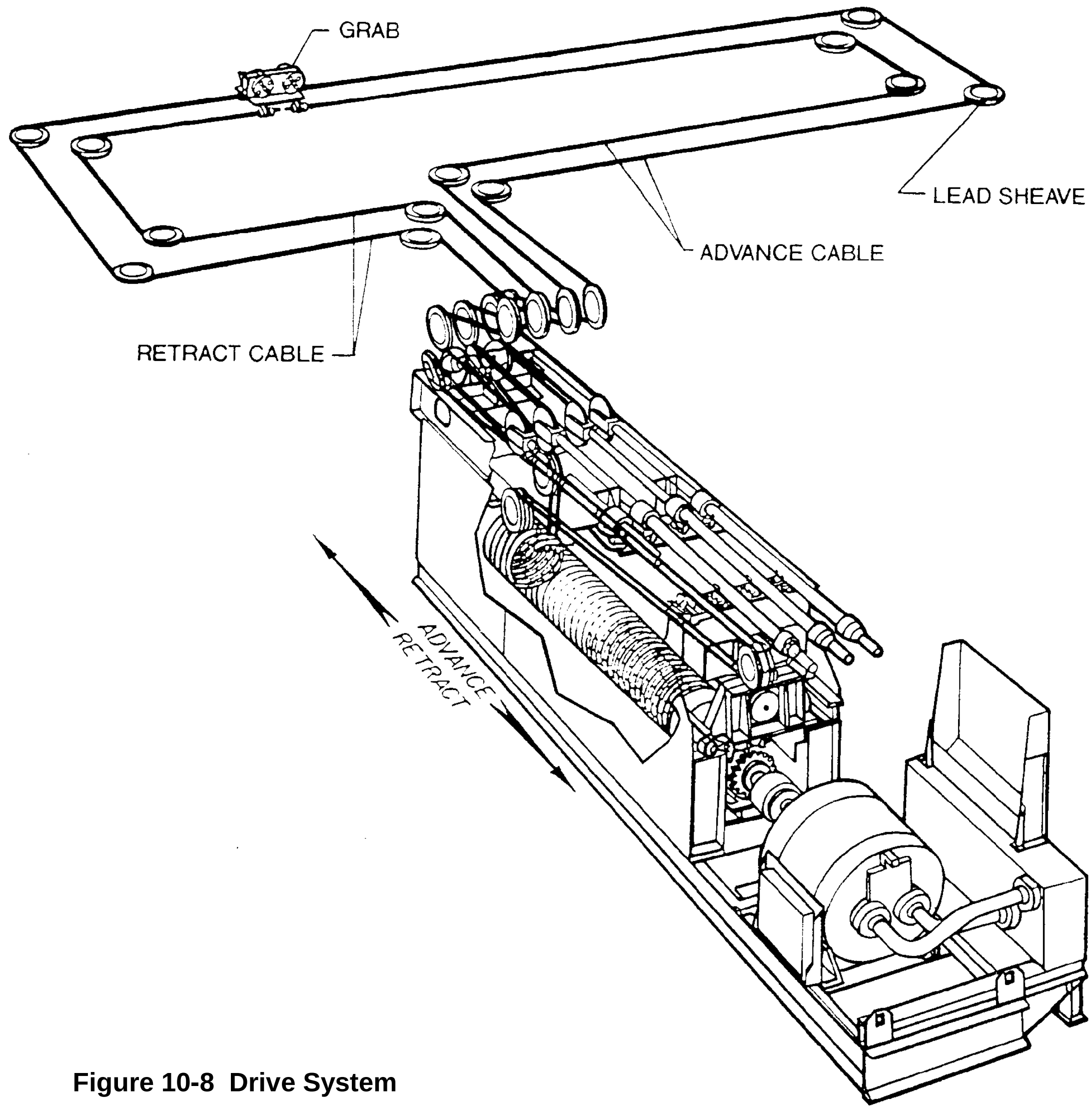


Figure 10-8 Drive System

10.3.4 Hydraulic System. The catapult hydraulic system is the operational center of the catapult. This system is made up of a main storage tank (gravity tank), three main hydraulic pumps, and accumulator, and air storage flask, an auxiliary storage tank, and auxiliary pump, circulating pump, fluid cooler and various control valves and associated piping. *(Figure 10-9)*. This installation provides a means to control the opening and closing of valves which in turn allow the different phases of operation to occur. The system pressure varies with the type of installation, 2500-2750 psi., pressure is maintained in the accumulator assembly which supplies all the various components with medium pressure hydraulic fluid. Due to the flow of the hydraulic fluid through pumps, valves and piping, the fluid heats up and circulates through a fluid cooler to ensure that it is maintained at the proper operational level. This system is a recirculating system with a 1,000 gallon fluid capacity. Replenishment of the system is accomplished by pouring fluid from the flight deck into a inlet down into the storage tank below decks. The fluid passes through several strainers and filters before entering the gravity tank to ensure that the system does not become contaminated.

10.3.5 Bridle Tensioning System. The bridle tensioning system of the catapult consists of a deck tensioner *(Figure 10-10)*, controlling valves, pressure regulator and associated piping. This system is operated hydraulically using a reduced amount of pressure. To launch an aircraft from the catapult it must first be properly tensioned on the catapult. To accomplish this a unit is installed directly below the flight deck in the catapult approach area to apply a force of 4,000 lbs. against the nose gear of an aircraft (depending on the type of aircraft). Once properly positioned on the catapult an aircraft is anchored to the deck by a holdback unit, which varies with the type of aircraft, and then the deck tensioning unit strokes forward to push the shuttle assembly out which applies tension to the aircraft. The bridle tensioning system works in conjunction with the retraction engine and drive systems to allow the grab to be moved forward with the motion of the deck tensioner. Once the deck tensioner is stroked forward pushing against the grab, a latch on the grab releases the shuttle from the grab so the catapult can be fired.

10.3.6 Lubrication System. The catapult lubrication system consist of a storage tank, pump, control valve, metering pumps and injectors, various shutoff and supply valves and associated piping. *(Figure 10-11)* This system provides lubrication oil into the launching engine cylinders during operation to eliminate wear of the components of the launching engine.

The operation of the lubrication system is automatic during operations and can be manually actuated for maintenance purposes. The system storage tank capacity is 220 gallons. The amount of one gallon of oil is used per cycle of the catapult. The lube oil is drawn out of the tank by an electric driven pump which maintains system pressure at approximately 150 psi. Once the entire system has been pressurized, lube oil is supplied to 52 separate metering pumps located along the sides of the catapult trough below the flight deck.

During operation of the catapult each metering pump delivers oil into injector nozzles mounted in the launching engine cylinder covers which spray the inside of the cylinders with lube oil. This occurs when the catapult is in the Retract and Military Power (Standby) phases of operation. Low pressure air is allowed through a solenoid operated pilot valve which shifts the lubrication control valve and directs pressurized hydraulic fluid then forces lube oil out of the metering pumps and into the cylinder cover nozzles. This action provides a sufficient amount of lube oil to be sprayed into the launching engine cylinders for one cycle of the catapult. There are three injector nozzles mounted in each cylinder cover section to provide even distribution of oil into the cylinders. This oil then provides lubrication for the piston and spear assemblies which travel fore and aft inside the launching cylinders.

This system is fully automated during operations and may also be manually actuated as desired by remote pushbuttons located on the catapult control panels.

Replenishment of this system is accomplished by pumping oil from the main ships storage tank, located several decks below the catapult, into the lubrication system storage tank. During this process the oil passes through several strainers and filters to ensure it does not become contaminated. Dirt in the lubrication system could cause clogging of the injector nozzles reducing the capability of the system.

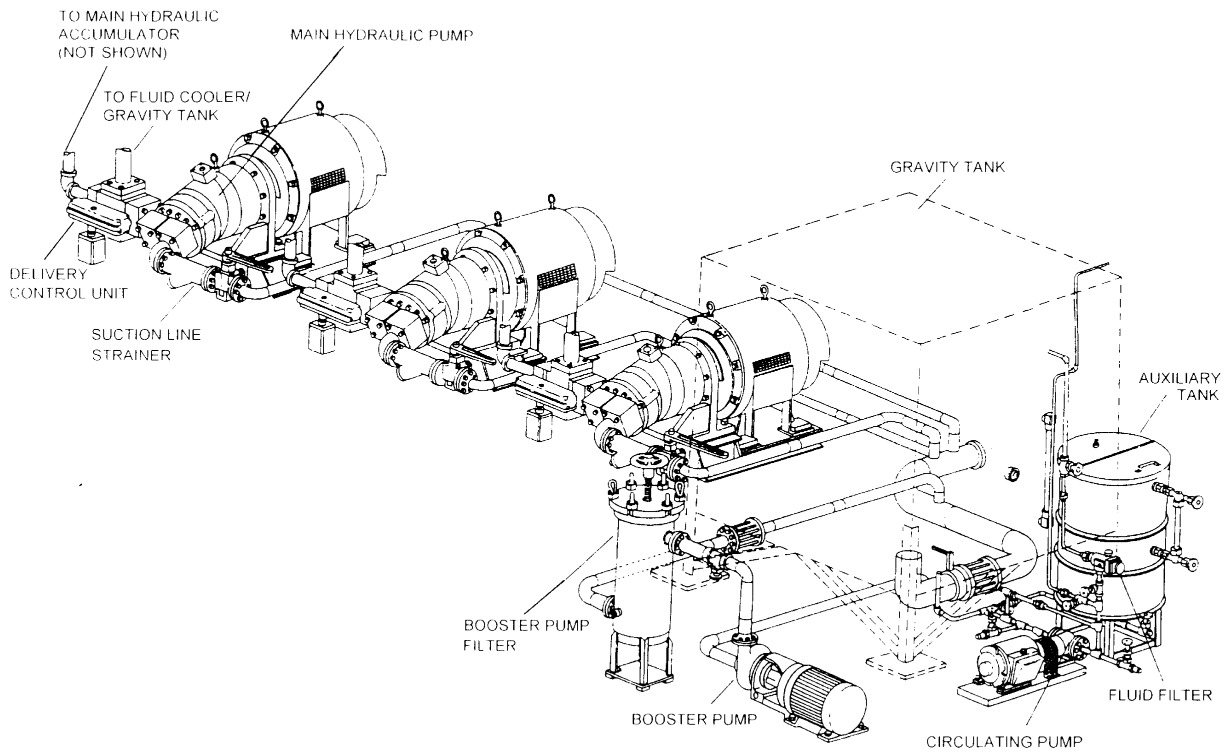


Figure 10-9 Hydraulic System

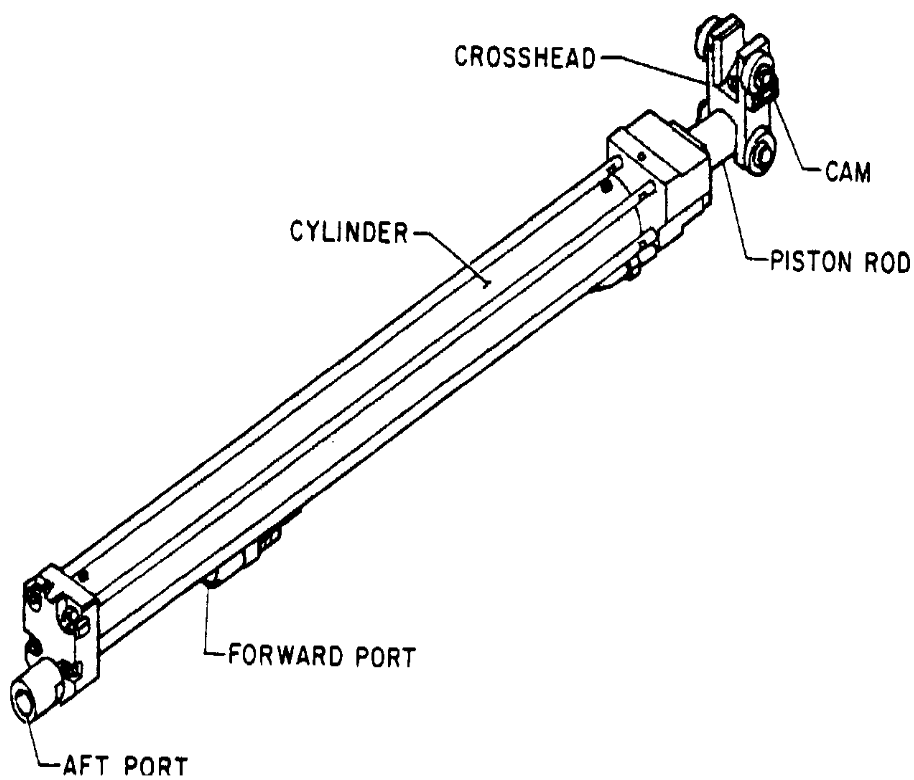


Figure 10-10 Deck Tensioner

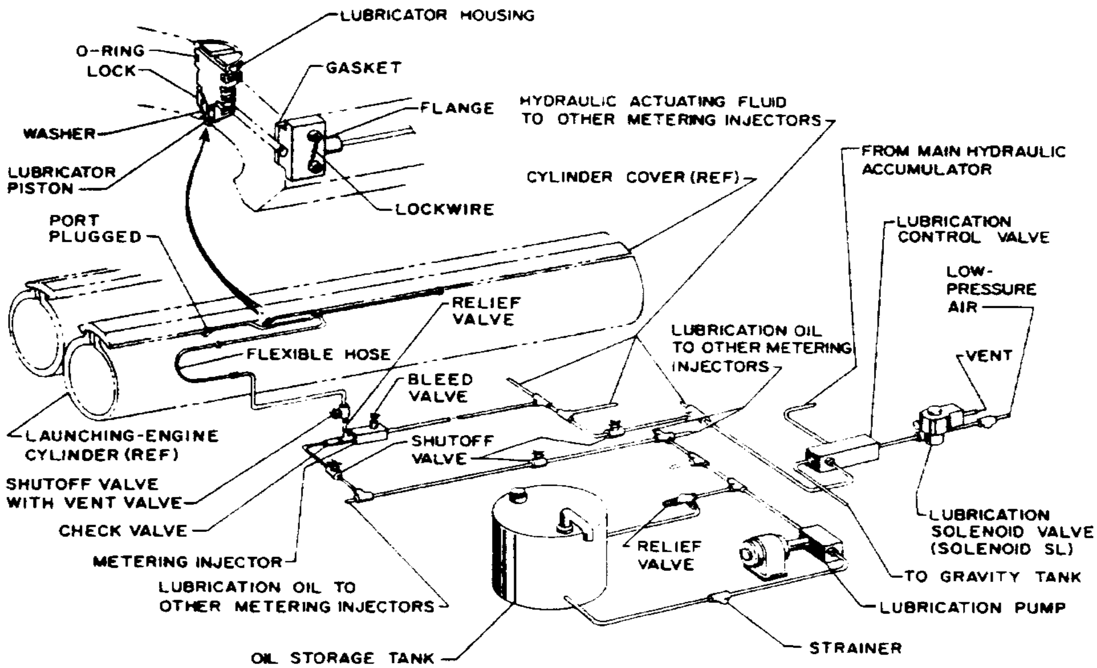


Figure 10-11 Lubrication System

10.3.7 Control System. The catapult control system controls all phases of catapult operation electronically. Depending upon installation and the type of catapult, the control system will vary with each station. The most common control system consists of a main control console (not on board ships with the Integrated Catapult Control Station), charging panel, deck edge control panel and an auxiliary deck panel signal box.

Ships with the newest type C-13-1 and the C-13-2 catapults have the Integrated Catapult Control Station (ICCS). The ICCS incorporates a catapult officers control console, a monitor control console, a central charging panel and an auxiliary deck edge control panel with a deck signal box. All of these items are located in a glass covered vertical movable well in the deck between cats one and two and on the port side of the ship for cats three and four.

On those ships without ICCS, the catapult officer stays on deck and must signal the deck edge operator when to fire the cat. In the ICCS configured ships the catapult officer is in the ICCS deck well and fires the cat himself.

Although somewhat different in appearance and phases of operation, the function of both control systems remains the same.

10.3.7.1 Charging Panel Assembly. The heart of the catapult control system is the charging panel assembly. At this station an operator monitors all the functions of the catapult and ensures all the proper operating pressures, temperatures and conditions are maintained. A console with pressure gauges, indicator lights, charging valves and blowdown valves makes up the charging panel assembly. The status of all the catapult equipment can be observed and controlled at this station. The charging panel assembly shown is a C-13/C-13-1 installation without the ICCS *(Figure 10-12).* The C-13-1 ICCS charging panel consists of four front panel assemblies and eliminates the need for the main control console.

10.3.7.2 Main Control Console. The main control console of non-ICCS catapults *(figure 10-13)*, is the real nerve center of the catapult. The main control console provides a means of controlling the catapult through its various stages of operation. It also indicates the status of the steam and hydraulic systems to the console operator. Although most of the functions of the catapult are controlled at the main control console, actual firing and bridle tensioning are controlled directly from the deck edge station. These two functions may, however, be transferred to the main control console in the event of an emergency condition.

Both the charging panel assembly and the main control console are located below deck near the launching valve enclosure. The operators of these stations establish sound powered phone communication with other station crewmembers during operation.

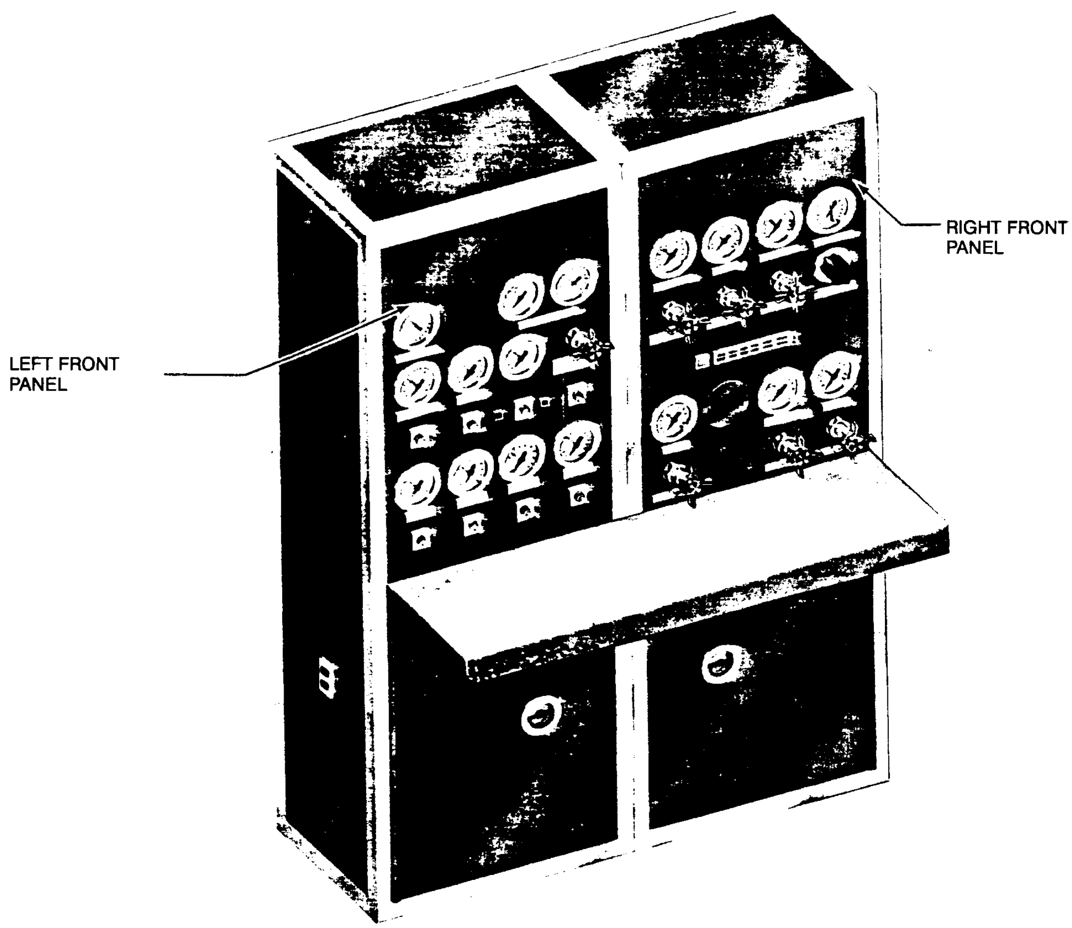


Figure 10-12 C-13/C13-1 Central Charging Panel Installation

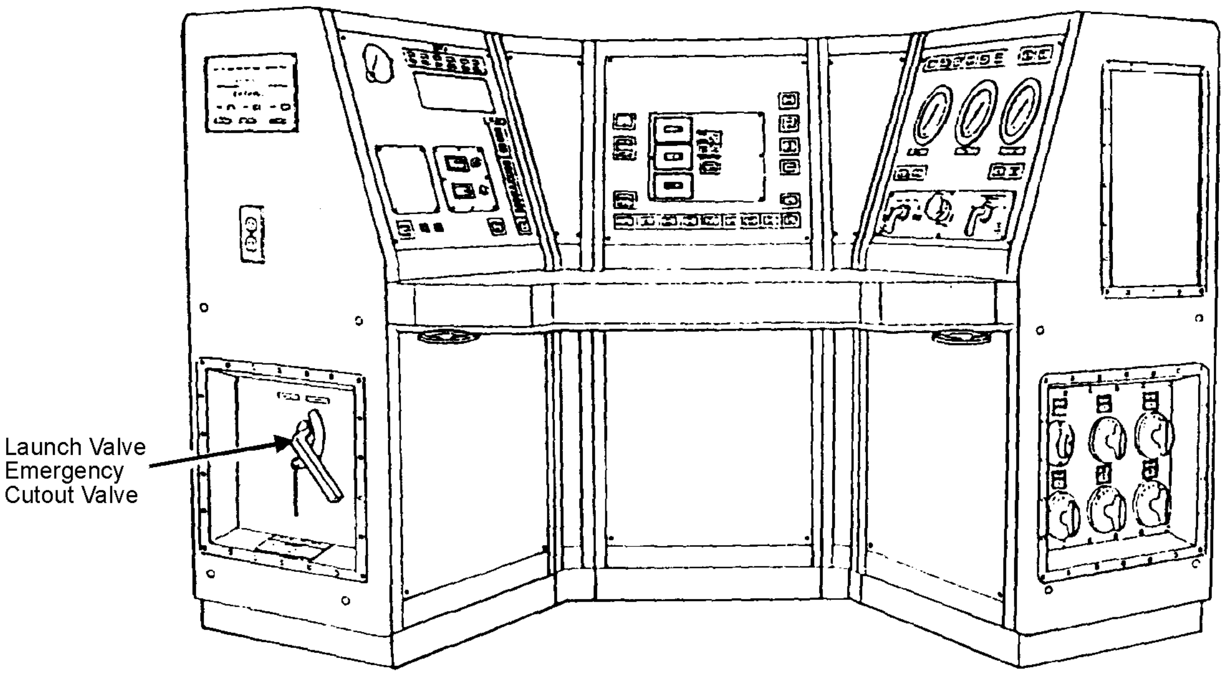


Figure 10-13 Main Control Console

10.3.7.3 Deck Edge Control Panel. The deck edge control panel *(Figure 10-14)*, is located on the catwalk at the edge of the flight deck. The deck edge control panel is used in conjunction with the control console to direct the catapult through a normal launching cycle, (non-ICCS installations). Under emergency conditions, the functions of the deck edge control panel are transferred to the main control console. ICCS installations utilize the deck edge control console as an emergency mode of operation and can also transfer its capabilities to the central charging panel in the event of an emergency.

10.3.7.4 Repeater Panel. The repeater Panel (aux, deck signal light box) is located adjacent to the deck edge station *(Figure 10-15)*. It gives the catapult officer on deck a visual indication of the status of the catapult during operations.

10.3.7.5 Pri-Fly control Panel. The Pri-fly control panel is located in the flight officer's control center. Standby lights and catapult suspend lights on the panel indicated the condition of readiness for each catapult. Catapult suspend switches on the panel permit launchings to be suspended from the control center in an emergency.

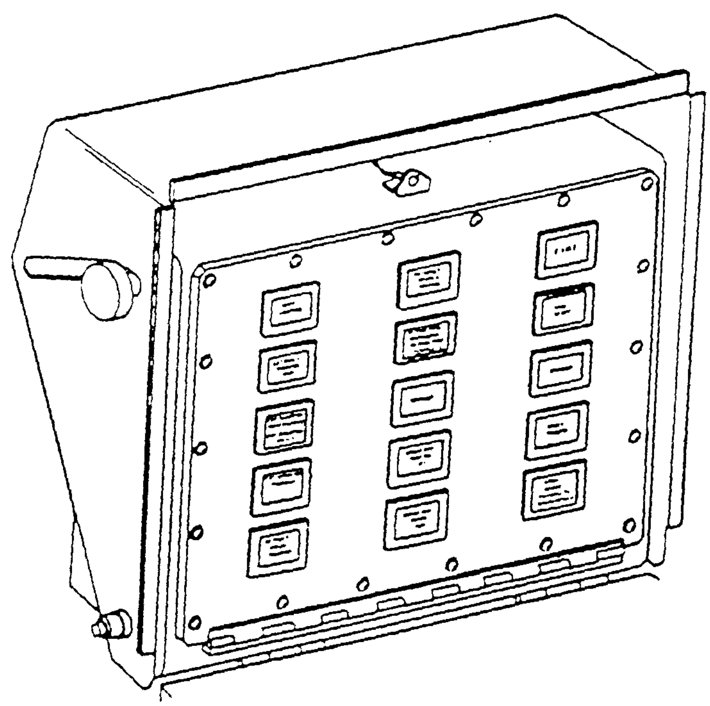


Figure 10-14 Deck Edge Control Panel

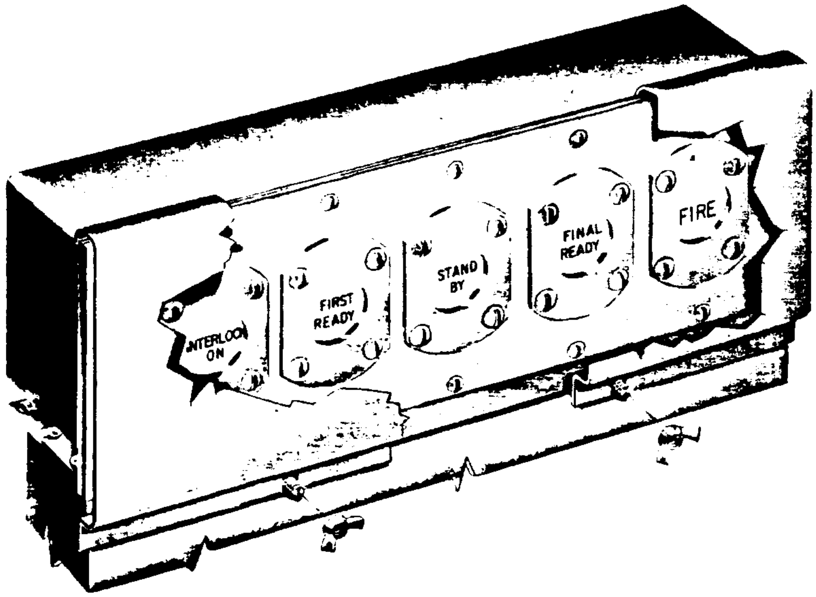


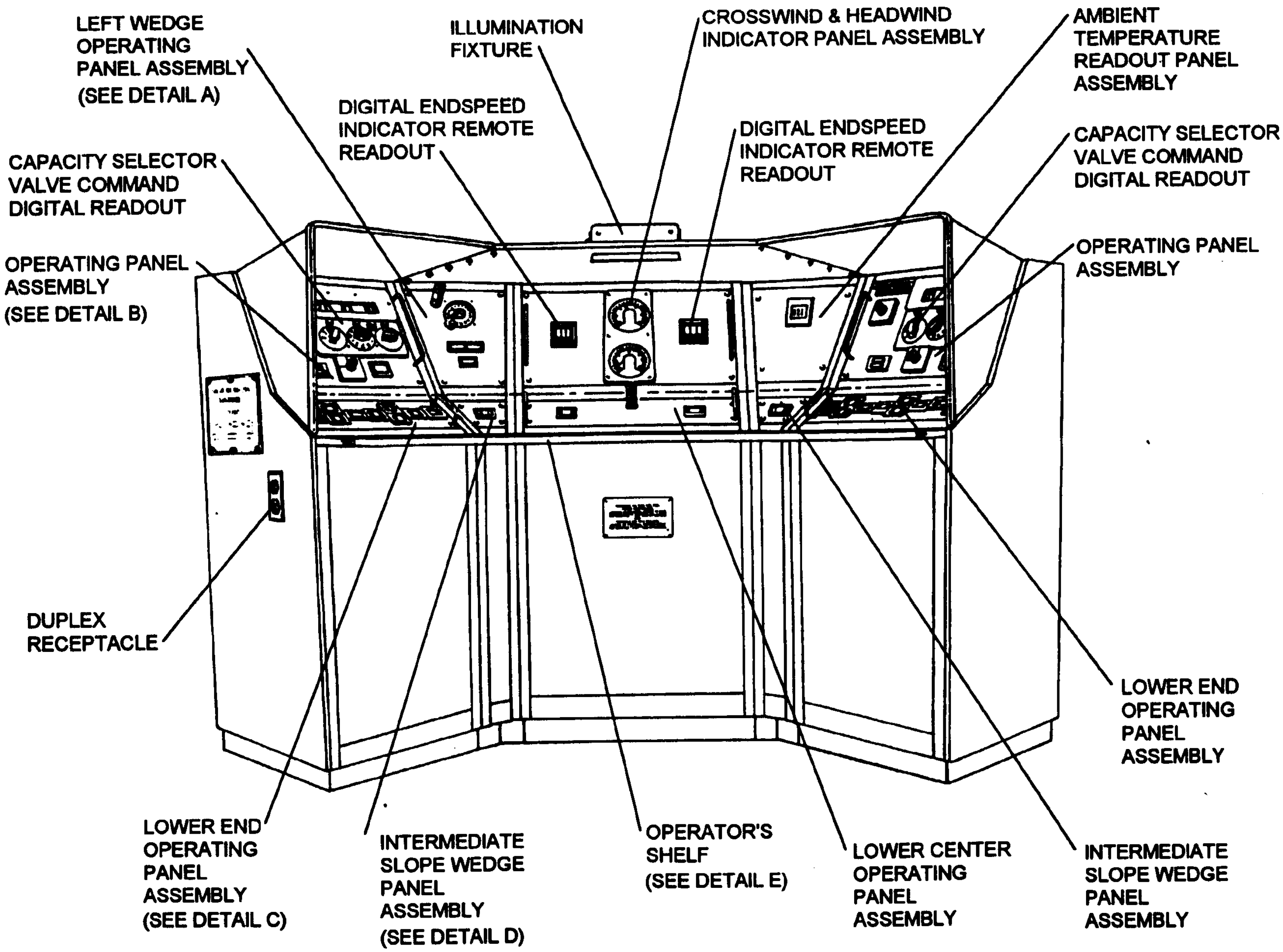
Figure 10-15 Repeater Panel

10.3.7.6 Catapult Officers Control Console. The Catapult Officers Control Console *(Figure 10-16)* is located in the ICCS. The control console provides the launch officer with the necessary controls and information to conduct launching operations on two adjacent catapults. The control assembly is made up of a series of panels. The operating and lower end operating panels contain the controls for capacity selector valve (CSV) setting and the switches and pushbuttons for conducting launching operations. In addition, each operating panel contains a selector switch to energize circuits for conducting either nose tow or bridle/pendant type operations and steam pressure go/no-go lights.

The panels located between the operating panels provide the launching officer with the switches and indicators that apply to both catapults. This includes a 24 hour clock, catapult interlock lights, pri-fly go/no-go lights, wind speed readout indicators, ambient temperature readout, night lighting, push-to-test switches, and a switch for raising/lowering the ICCS cab.

10.3.7. Center Deck Control Station. The Center Deck Control Station is a part of the control system in that it is vital as a visual and communications link between the catapult officer and the main control console (non ICCS). It contains a wind speed and direction indicator, sound powered phone circuits and the controls necessary to mechanically indicate to the main console operator the desired CSV or steam pressure setting. ICCS installations enable the catapult officer to set the desire CSV setting personally.

10.3.7.8 Monitor Control Console. *(Figure 10-17)* Located on the left side of the Main Control Console, it contains status lights for low-pressure air, hydraulic temperature and pressure, lube pressure, and bridle tension pressure; malfunctioning lights (12); and read-outs for end speed and L.V. stroke timer. This console displays the health of all the systems that make up the catapult.


LEFT WEDGE OPERATING PANEL ASSEMBLY (SEE DETAIL A)
ILLUMINATION FIXTURE
CROSSWIND & HEADWIND INDICATOR PANEL ASSEMBLY
AMBIENT TEMPERATURE READOUT PANEL ASSEMBLY
DIGITAL ENDSPEED INDICATOR REMOTE READOUT
DIGITAL ENDSPEED INDICATOR REMOTE READOUT
CAPACITY SELECTOR VALVE COMMAND DIGITAL READOUT
CAPACITY SELECTOR VALVE COMMAND DIGITAL READOUT
OPERATING PANEL ASSEMBLY (SEE DETAIL B)
OPERATING PANEL ASSEMBLY
DUPLEX RECEPTACLE
LOWER END OPERATING PANEL ASSEMBLY
LOWER END OPERATING PANEL ASSEMBLY (SEE DETAIL C)
INTERMEDIATE SLOPE WEDGE PANEL ASSEMBLY (SEE DETAIL D)
OPERATOR'S SHELF (SEE DETAIL E)
LOWER CENTER OPERATING PANEL ASSEMBLY
INTERMEDIATE SLOPE WEDGE PANEL ASSEMBLY

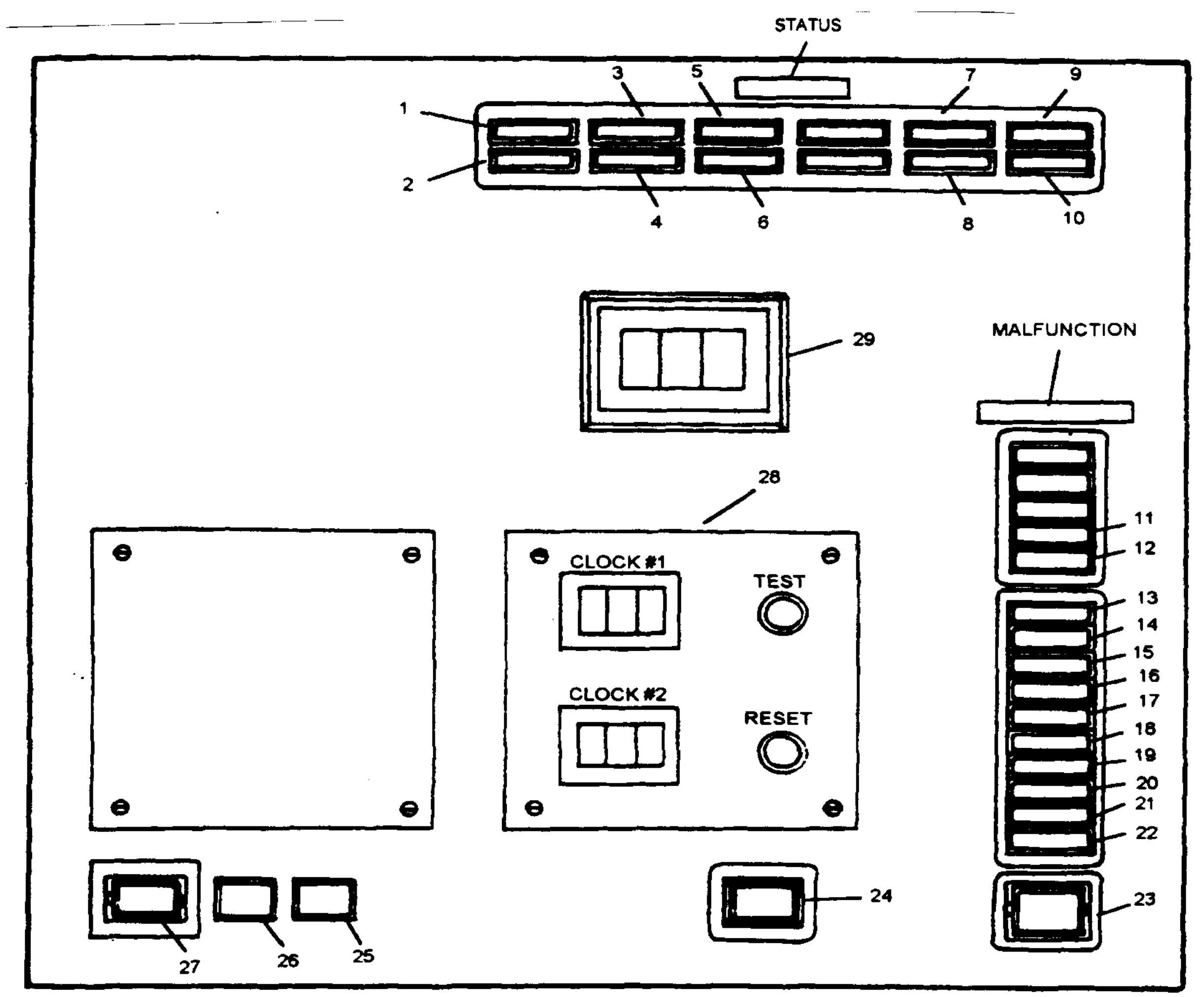


Figure 10-17 Monitor Control Console

STATUS LIGHTS
1. LOW-PRESSURE AIR (RED)
2. LOW-PRESSURE AIR (GREEN)
3. HYDRAULIC FLUID TEMP (RED)
4. HYDRAULIC FLUID TEMP (GREEN)
5. LUBE PUMP PRESSURE (RED)
6. LUBE PUMP PRESSURE (GREEN)
7. HYDRAULIC PRESSURE (RED)
8. HYDRAULIC PRESSURE (GREEN)
9. BRIDAL TENSION PRESSURE (RED)
10. BRIDAL TENSION PRESSURE (GREEN)

MALFUNCTION LIGHTS
11. ACCUMULATOR VALVE POSITION
12. EMERGENCY LAUNCH COMPLETE
13. CSV SETTING
1. FIRE P.B.1.
2. BRIDAL TENSION POSITION
3. EXHAUST VALVE
4. INTERLOCK COMPLETE RELAY
5. SUSPEND RELAY
6. L.V. CUTOUT VALVE
7. HYDRAULIC ACCUMULATOR VOLUME
8. WATER BRAKE PRESSURE
9. LAUNCH VALVE
10. PUSH-TO-TEST
11. BLOW THROUGH NO-LOAD P.B.
12. TIMER RESET FUSE
13. TIMER MOTOR FUSE
14. TIMER POWER ON P.B.
15. L.V.STROKE TIMER READOUTS
29 DIGITAL END SPEED INDICATOR

10.4 PHASES OF OPERATION

The evolution of launching aircraft can be easily divided into the following four areas:

10.4.1 Preparing Aircraft for Launch. The aircraft is spotted just aft of the shuttle at the battery position. After the holdback is installed the aircraft is attached to the shuttle, the bridle tensioner is actuated applying pressure against the grab and moving the shuttle forward to tension the aircraft.

10.4.2 Firing the Catapult. After tensioning, the catapult is fired by opening the launching values and permitting steam to surge into the cylinders. The force of the steam pushes the piston in the cylinder breaking the tension bar. The steam then forces the piston forward, towing the shuttle and aircraft at an ever increasing speed.

10.4.3 Halting the Piston and Shuttle. As the piston approaches the water brake, a switch (launch complete) is actuated by the steam in the cylinders.

This causes the launch valve to close, stopping the flow of steam into the cylinder and the exhaust valve to open and exhaust the spent steam. At about the same time, the retraction engine is set in motion to advance the grab. At the forward end of the shuttle track the grab latches onto the shuttle.

10.4.4 Readying the Catapult for the next aircraft. The retraction engine is reversed and returns the grab, shuttle and pistons to the battery position. The catapult has completed a full cycle and is in position to launch another aircraft.

10.5 MALFUNCTIONS

Slow shot: Incorrect steam pressure or CSV settings; insufficient volume of hydraulic fluid; or binding of launch engine components.

Cold Shot: Launching engine is not sufficiently hot causing the cold steel to sap the strength (expansion) out of the steam.

Runaway Shot: The catapult becomes disconnected from the aircraft at the beginning or during the power stroke. With out the weight of the aircraft, the catapult accelerates, unhindered, forward into the water brakes usually exceeding its stopping power.

10.6 EMERGENCIES

Suspend: The launching sequence is electrically interrupted prior to the fire button being pushed.

Hangfire: Exists when the fire button has been depressed and the catapult fails to fire.

CHAPTER 11

SHOREBASED VISUAL LANDING AIDS

11.1 GENERAL

There are presently two optical landing aids used aboard Naval Air Stations. A third is being added and will eventually replace the Mk 8 Fresnel lens.

1. Mk 8 Fresnel Lens

   a. Mod 0: Equipped with roll angle drive assembly, no cut lights unless service change 43 is incorporated.

   b. Mod 1: Equipped with cut lights but not with roll angle drive assembly

2. MOVLAS (Mk 2 Mod 2)

3. Improved Fresnel Lens Optical Landing Aid System (IFLOLS).

Ship Installations Equipment Handbook CD-1025, Naval Air Engineering Center, Lakehurst, N.J., lists numbers, types, and certification dates for FLOLS equipment at each air station.

NOTE

Visual landing aids which are installed as a part of an air station's normal approach lighting and marking scheme may be configured to activate the runway waveoff light system (wheels up waveoff lights) whenever the lens waveoff lights are activated by the tower, wheels watch, or the LSO's pickle switch. Use of this configuration may not be suitable for conduct of FCLPs. Refer to NAVAIR 00-80-T-114 (AYC Facilities Manual).

11.2 MK 8 MOD 1 FRESNEL LENS

The Mk 8 Fresnel lens is nearly identical to the shipboard variant. The datum arms may be pinned inward against the power control unit when not in use. On/off and intensity controls are provided for independent control of source, datum and combined cut and waveoff lights. Proper temperature and unit ready indication are identical to those described in the FLOLS section. A jack screw and hand crank on the front of the trailer base is used to adjust desired glideslope on the Mk 8 Mod 1. A mirrored pole is provided with the unit to check glideslope settings (the Mk 8 is the only unit which comes standard equipped with a pole) *(Figure 11-1)*.

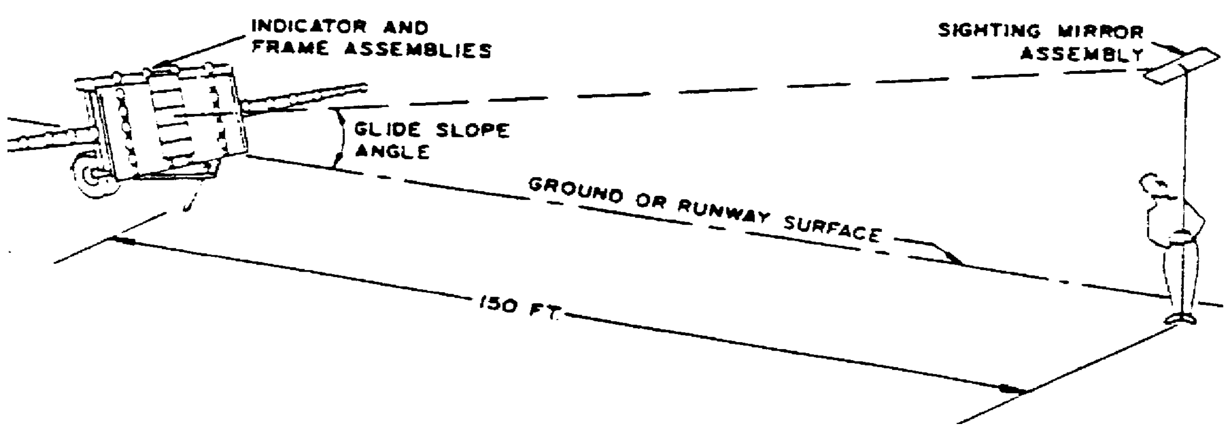
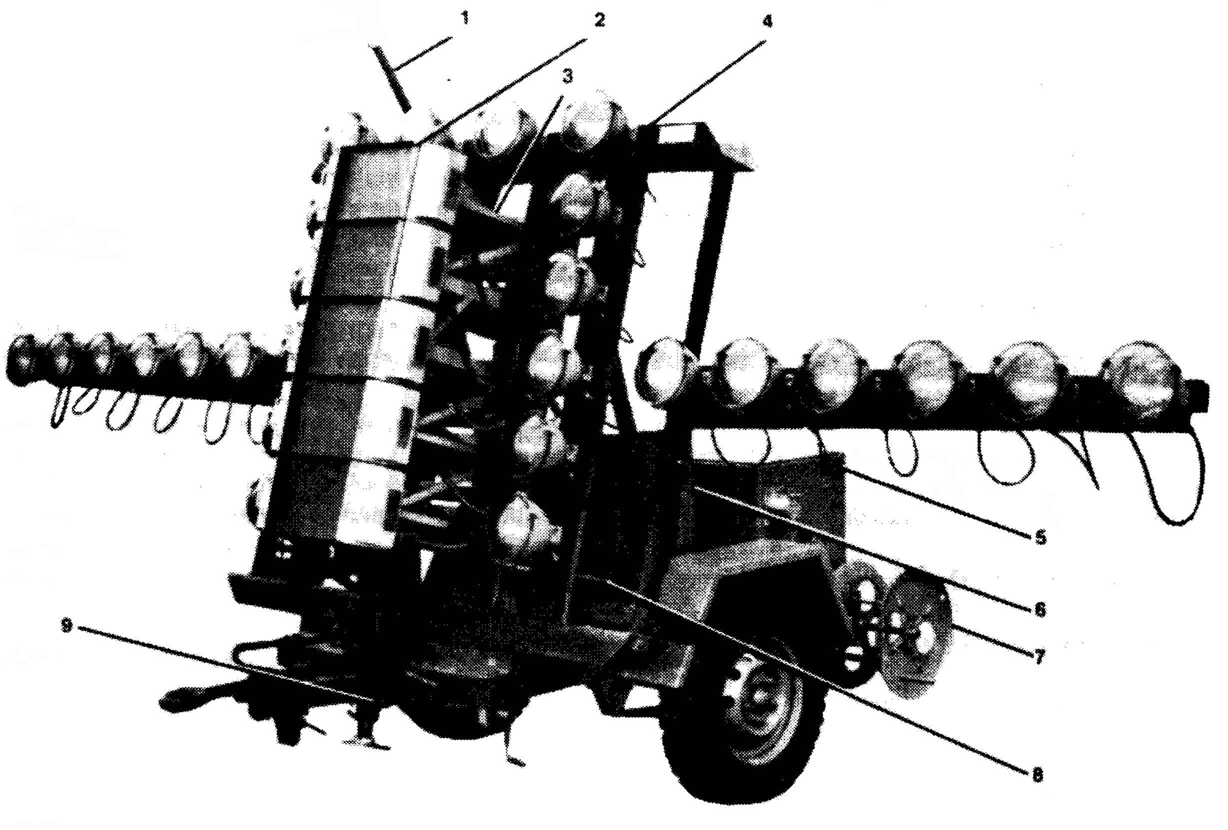


Figure 11-1 Setup of Sighting Mirror Assembly for Adjustment of Glideslope Angle



1. Mirror Assembly	4. Frame Assembly	7. Reel Assembly
2. Cell Assembly	5. Control Box Assembly	8. Junction Box Assembly
3. Cell Frame Assembly	6. Spare Parts Box Assembly	9. Jack Assembly

Figure 11-2 Portable Shorebased Fresnel Lens Optical Landing System, Mk8 Mod1

11.2.1 General Description of Operation. The portable shorebased Fresnel system *(Figure 11-2 and 11-3)* consists of six major assemblies. These assemblies are:

a. Control box assembly A100.

b. Junction box assembly A200.

c. Pickle switch assembly A330.

d. Frame assembly A400.

e. Cell assemblies.

f. Source light failure indicator assembly A500.

The six assemblies function together to transmit landing information by means of light signals to the pilot of an approaching aircraft. The operation of the six assemblies is described below.

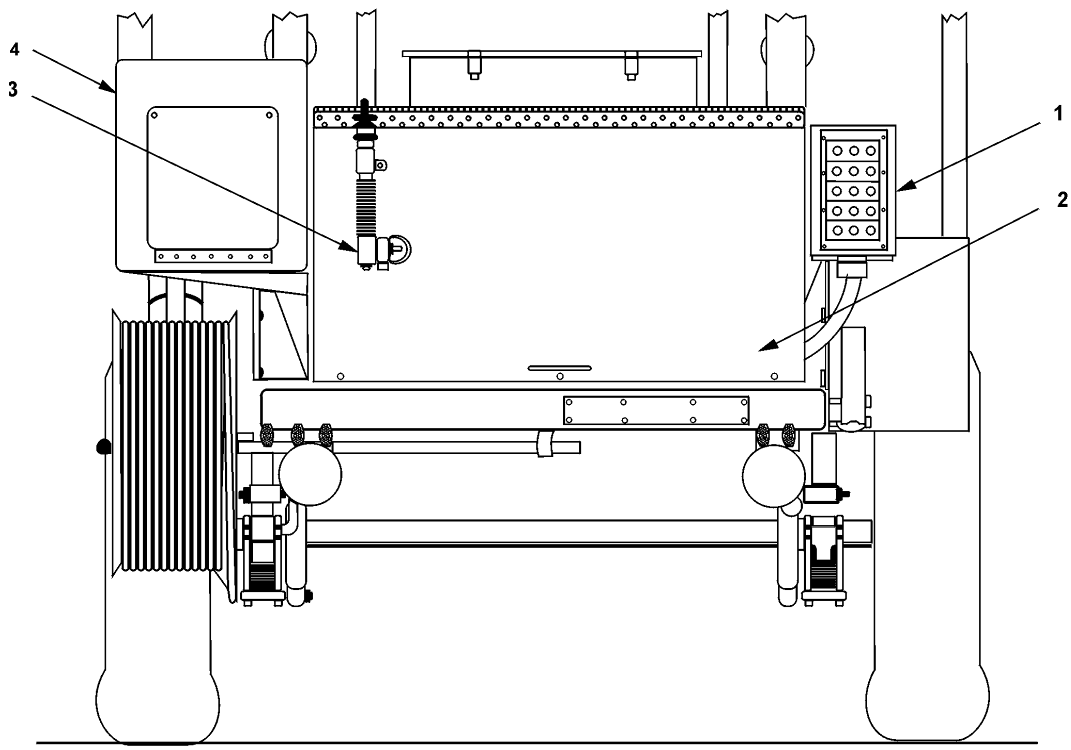
11.2.1.1 Operation of Control Box Assembly A100. The control box assembly A100 is used to control the application and removal of AC input voltage necessary for operation of the portable shorebased Fresnel system. The control box assembly receives AC voltage from the portable power-generating equipment and applies the AC voltage to frame assembly A400 and indicator assembly A402. Circuit breakers within the enclosure protect the cell assembly A400 from current overloads. Variable transformers in the control box assembly are used to regulate the intensity of illumination of the source lights and datum lights *(Figure 11-4)*. The separate waveoff intensity control box provides independent regulation of the illumination of the waveoff lights. Relay circuits in the control box assembly control the application of power to the waveoff lights.

11.2.1.2 Operation of Junction Box Assembly A200. Junction box assembly A200 is used as a junction point for cables from control box assembly A100, from the cell assemblies, from the various lights on frame assembly A400, and from the source lights failure indicator assembly. The incoming cables are connected to terminal boards within the enclosure; internal circuitry electrically connects the cables so that the AC voltages are applied throughout the system.

11.2.1.3 Operation of Pickle Switch Assembly A330. The pickle switch assembly A330 is used to control the lighting of the waveoff and cut lights on frame assembly A400 *(Figure 11-5)*.

Switches within the pickle switch assembly are electrically connected to a relay circuit in control box assembly A100. When the switches are pressed, the relay circuit is energized and, in turn, applies voltage to waveoff and cut lights.

11.2.1.3.1 Waveoff Lights. The waveoff lights are controlled by pickle switch assembly A330, circuitry in the control box assembly A100, and by the externally connected separate waveoff intensity control. The waveoff lights flash at 90 times per second. When illuminated, the conditional datum lights go out on each side of the source lights.



1. Source Light Failure Indicator Assembly
2. Control Box Assembly
3. Pickle Switch Assembly
4. Separate Wave-off Intensity Control Assembly

Figure 11-3 Portable Shorebased FLOLS, Mk 8 Mod 1 (partial rear view)

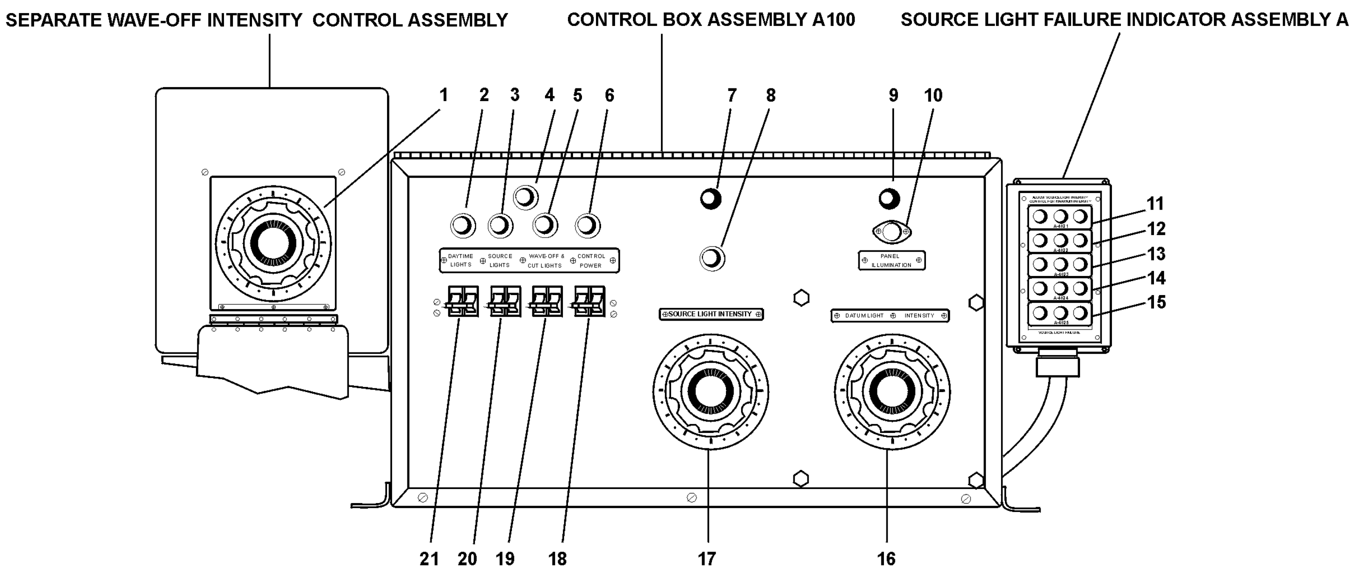


Figure 11-4 Control Box Assembly A100, Separate Waveoff Intensity Control Assembly A500 and Source Light Failure Indicator Assembly, Controls, Indicators and Uses.

Figure 11-3	CONTROL	USED
1	SEPARATE WAVEOFF & CUT LIGHT INTENSITY	To vary the intensity of waveoff and cut lights control (T104)
2	DATUM LIGHTS indicator (DS101)	When lit, to indicate that DATUM LIGHTS circuit breaker or (CB101) is in position Aon@ and that power is applied to datum lights
3	SOURCE LIGHTS indicator (DS101)	When lit, to indicate (CB101) that SOURCE LIGHTS circuit breaker is in position Aon@ and that power is applied to source lights in cell assemblies
4	PANEL ILLUMINATION indicator (DS105)	When lit, to illuminate control panel and to indicate that phase A of 3-phase 60-Hz voltage is applied to circuit breaker CB101
5	WAVEOFF & CUT LIGHTS (DS103)	When lit to indicate that indicator WAVEOFF & CUT LIGHTS circuit breaker (CB103) is in position "on"

6	CONTROL POWER indicator (DS104)	When lit, to indicate that CONTROL POWER circuit breaker (CB104) is in position "on" and that power is applied to cell assemblies and other circuitry
7	PANEL ILLUMINATION indicator (DS106)	When lit, to illuminate control panel and to indicate that phase C of 3-phase 60-Hz voltage is applied to circuit breaker CB103
8	UNIT READY indicator (DS108)	When lit, to indicate that proper lens operating temperature is being maintained
9	PANEL ILLUMINATION indicator (DS107)	When lit, to illuminate control panel and to indicate that phase B of 3-phase 60-Hz voltage is applied to circuit breaker CB102
10	PANEL ILLUMINATION fuse (F101)	To protect PANEL ILLUMINATION indicators from current overload
11	A4021 failure indicator (DS3-A, DS2-A and DS1-A)	When lit, to indicate that DS3-A, DS2-A or DS1-A in cell assembly A-4021 is faulty
12	A4022 failure indicator (DS3-B, DS2-B, and DS1-B)	When lit, to indicate that lamp DS3-B, DS2-B, or DS1-B in cell assembly A-4022 is faulty
13	A4023 failure indicator (DS3-C, DS2-C and DS1-C)	When lit, to indicate that lamp DS3-C, DS2-C, or DS1-C in cell assembly A-4023 is faulty
14	A4024 failure indicator (DS3-D, DS2-D, and DS1-D)	When lit, to indicate that lamp DS3-D, DS2-D, or DS1-D in cell assembly A-4024 is faulty
15	A4025 failure indicator (DS3-E, DS2-E, and DS1-E)	When lit, to indicate that lamp DS3-E, DS2-E, or DS1-E in cell assembly A-4025 is faulty
16	DATUM LIGHT INTENSITY (T103)	To vary the intensity of control datum lights
17	SOURCE LIGHT INTENSITY control	
18	CONTROL POWER circuit breaker (CB104)	To apply and remove ac input power for cell assemblies and other circuitry and to protect cell assemblies from current overload
19	WAVEOFF & CUT LIGHTS circuit breaker (CB103)	To apply and remove ac input power for waveoff light circuitry and to protect waveoff lights from current overload
20	SOURCE LIGHTS circuit breaker (CB102)	To apply and remove ac input power for source lights in cell assemblies and to protect source lights from current overload
21	DATUM LIGHTS CIRCUIT breaker (CB101)	To apply and remove ac input power for datum lights and to protect datum lights current overload

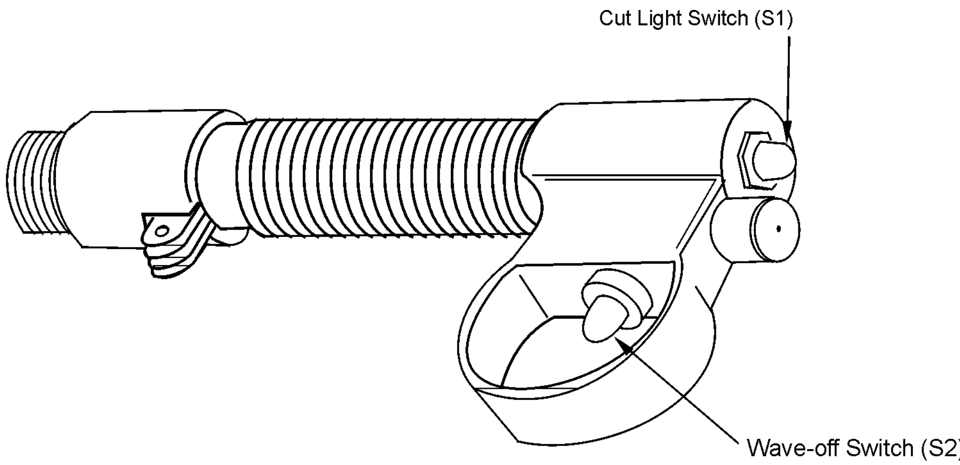


Figure 11-5 Portable (Pickle) Switch Assembly A330 and Components

CONTROL	USED
Cut light switch (S1)	When pressed to light or extinguish cut lights
Waveoff light switch (S2)	When pressed to light or extinguish waveoff lights

11.2.1.3.2 Cut Lights. The cut lights, presently used to signal "Roger Ball" and "power" to approaching aircraft which may be NORDO, or during EMCON or ZIP-LIP conditions, are controlled by pickle switch assembly A330, circuitry in control box assembly A100, and by the externally connected separate waveoff and cut light intensity control box.

11.2.1.4 Operation of Frame Assembly A400. Frame assembly A400 is used for mounting the conditional and fixed datum lights, waveoff lights, and cut lights which are used for conveying landing information to the pilot of an approaching aircraft. The conditional and fixed datum lights provide a light pattern to which the bar of light in the cell assemblies is referenced. Circuitry within control box assembly A100 controls the application of power to the datum lights and, in addition, controls the intensity of illumination of the lights.

11.2.1.5 Operation of Cell Assemblies. Five cell assemblies, mounted on a frame assembly, provide the bar of light that is aligned with the datum lights on frame assembly A400 for establishing the correct glideslope angle for an approaching aircraft. Each cell assembly contains an optical system of source lights, Fresnel lens, and lenticular lens that provides the bar of light. In addition, each cell assembly contains blower motors, heaters, and thermostats which maintain the correct lens operating temperature within the cell. Power is applied to the cell assemblies from control box A100.

11.2.1.6 Operation of Source Light Failure Indicator Assembly A500. The source light failure indicator assembly A500 consists of 15 neon indicators which permit detection of a faulty source lamp. Each cell assembly contains three source lamps. Should any light fail in one of the five cell assemblies, AC voltage is applied to the corresponding source light failure indicator, and the exact location of the faulty light would be known immediately upon visual observation of the source light failure indicator.

11.2.2 Operating Procedure. For correct operation of the portable shorebased Fresnel system, the brightness controls on control box A100 and separate waveoff intensity control box must be adjusted for proper light intensity of the source lights, the datum lights, waveoff lights, and cut lights. Excessive intensity of the lights causes light spillage, interference with pilot's vision, reflection of light into the background and an afterglow. The reflection of light into the background hampers proper identification of the meatball indication by the pilot on approach and may cause mistaken identification of light reflection for a nonexistent meatball indication. The afterglow may impede the pilot's vision in the final stages of approach, prevent him from recognizing a waveoff, and cause the loss of the glide path. Light brightness settings must always be maintained near the minimum required intensity to compensate for ambient light and weather conditions. The brightness settings are determined by the position of the lens with respect to the sun and by the decision of the LSO. In clear and sunny weather, medium settings are to be used; during periods of light fog or haze, higher settings are required. In clear weather between sunset and sunrise, a low brightness setting is desirable in order not to impair the night vision adaptation of the pilot. The operating procedure is as follows:

CAUTION

Exercise extreme care when selecting brightness setting for datum, waveoff, and cut signs. Select the minimum brightness setting that is suitable for ambient light and weather conditions. Do not change brightness during aircraft landing. Doing so may result in the loss of a glideslope reference for the approaching aircraft.

1. Turn SOURCE LIGHT INTENSITY control on control box A100 to a position which will produce a bar of light in the cell assemblies of intensity sufficient for visibility but not too intense for pilot of approaching aircraft.

2. Turn DATUM AND SEPARATE WAVEOFF & CUT LIGHT INTENSITY controls to a position which will light datum lights, waveoff lights and cut lights to intensity sufficient for visibility but not too intense for pilot of approaching aircraft.

3. Adjust glideslope angle to desired setting.

11.2.3 Normal Turnoff Procedure. Normal turnoff instructions are to be used when landing operations have been completed. To turn off the portable shorebase Fresnel system under normal conditions, the following steps should be performed:

1. Turn SOURCE LIGHT INTENSITY control on control box A100 fully counterclockwise (minimum brightness).

2. Turn DATUM AND SEPARATE WAVEOFF & CUT LIGHT INTENSITY controls fully counterclockwise (minimum brightness).

3. Set WAVEOFF & CUT LIGHTS circuit breaker on control box A100 to position "off" (down). WAVEOFF & CUT LIGHTS indicator goes out.

4. Set DATUM LIGHTS circuit breaker on control box A100 to position "off" (down). DATUM LIGHTS indicator goes out.

5. Set SOURCE LIGHTS circuit breaker on control box A100 to position "off" (down). SOURCE LIGHTS indicator goes out.

6. Set CONTROL POWER circuit breaker on control box A100 to position "off" (down). CONTROL POWER indicator goes out.

7. Turn off portable power-generating equipment. PANEL ILLUMINATION indicators on control box A100 go out.

8. Disconnect portable power-generating equipment from jack J101 on control box.

11.2.4 Emergency Turnoff Procedure. In the event that an emergency turnoff condition exists on the portable Fresnel system, the portable power-generating equipment should be turned off immediately.

11.3 THE MK 8 MOD 0 FLOLS

The Mk 8 Mod 0 is nearly identical to the Mk 8 Mod 1, but is equipped with a roll angle drive assembly so that the unit can be used for continuous short field arrestments; it was designed for use with Short Airfield Tactical Support (SATS). Aircraft Recovery Bulletin No. 80 series lists operating instructions and roll angle settings.

11.4 Land Based MOVLAS.

The Mk 2 Mod 2 land-based MOVLAS is compatible with the Mk 8 FLOLS, Mk 9 permanent mirror, and Mk 10 portable mirror (*figure 11-6)*, or be used independently. Refer to the shipboard MOVLAS discussion in Chapter 4 for further information concerning the MOVLAS system.

11.5 SHOREBASED LENS POLE CHECKS AND AIRCRAFT TOUCHDOWN POINTS

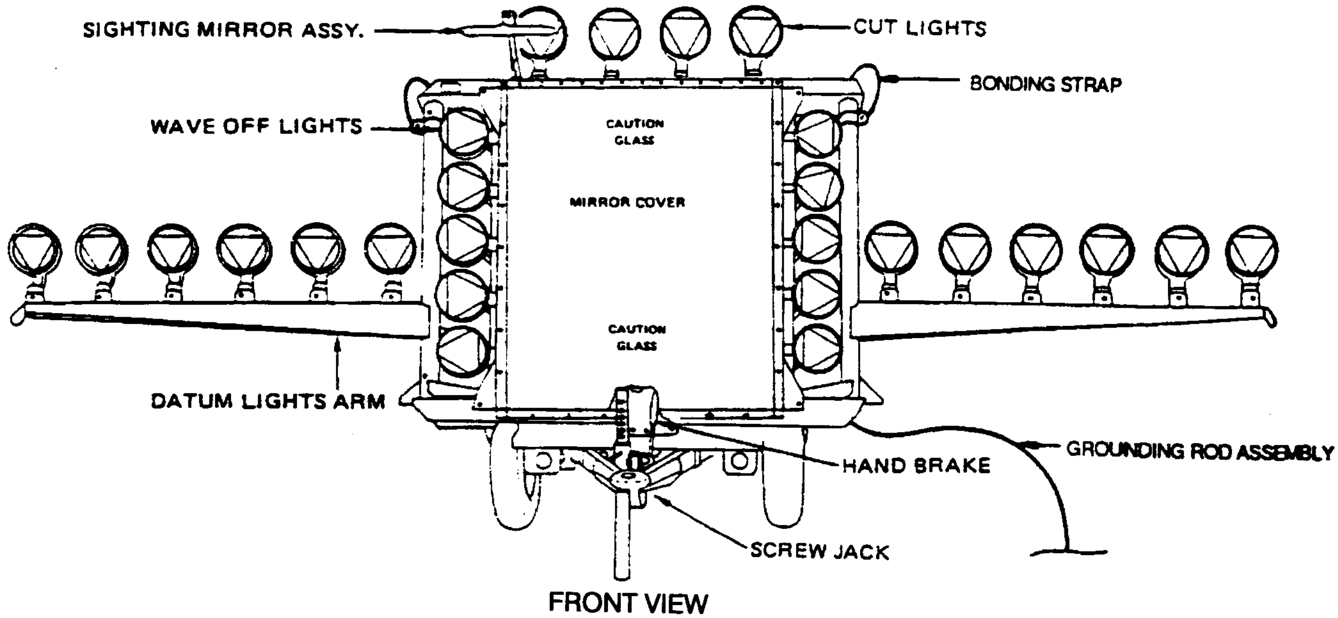
All shorebased optical systems are pole checked at a point 150 feet in front of the unit *(Figures 11-7 & 11-8)*. If the ground levels are different between sighting point and the trailer base you can add or subtract the difference from those listed in the figures or for each 8 inch difference in elevation, allow 1/4 degree on the sighting mirror assembly. For example, if a glideslope angle of 3 degrees is desired and the ground elevation at the sighting position is 16 inches below that of the trailer, the reading on the pole should be set to 3-1/2 degrees (1/4 degree for each 8 inch difference).

The height of the datum lights above the runway surface is different for each of the shorebased optical systems. This height difference results in slightly different approach geometry and aircraft touchdown point when using the various systems. Touchdown points also vary with each aircraft due to their differences in hook-to-eye (or main tires to eye). *(Figure 11-9)* The Mk 8 Mod 0 with its roll angle drive assembly is the exception and maintains a constant hook touchdown point.

Glideslope angle settings are marked on the pole for checking desired centered ball.

The following table provides hook touchdown points forward of (prior to) the lens at the field, for most aircraft. With a constant eyepath (glideslope) at the field, each aircraft will have a different hook touchdown point as a function of its hook-to-eye (H/E) valve

		GLIDESLOPE BASIC ANGLE Θ			
AIRCRAFT	HOOK-TO-EYE (H/E)	2-3/4^{O}	3^{O}	3-1/4^{O}	3-1/2^{O}
F-14A/B/D	19.70	323.4	296.4	273.6	254.0
EA-6B	18.75	303.6	278.3	256.8	238.4
F/A-18A/B/C/D	16.70	260.9	239.2	220.7	204.9
T-2C	12.00	163.1	149.5	138.0	128.1
C-2A E-2C/C+	15.00	225.6	206.7	190.8	177.1
S-3A/B	14.50	215.1	197.2	182.0	169.0



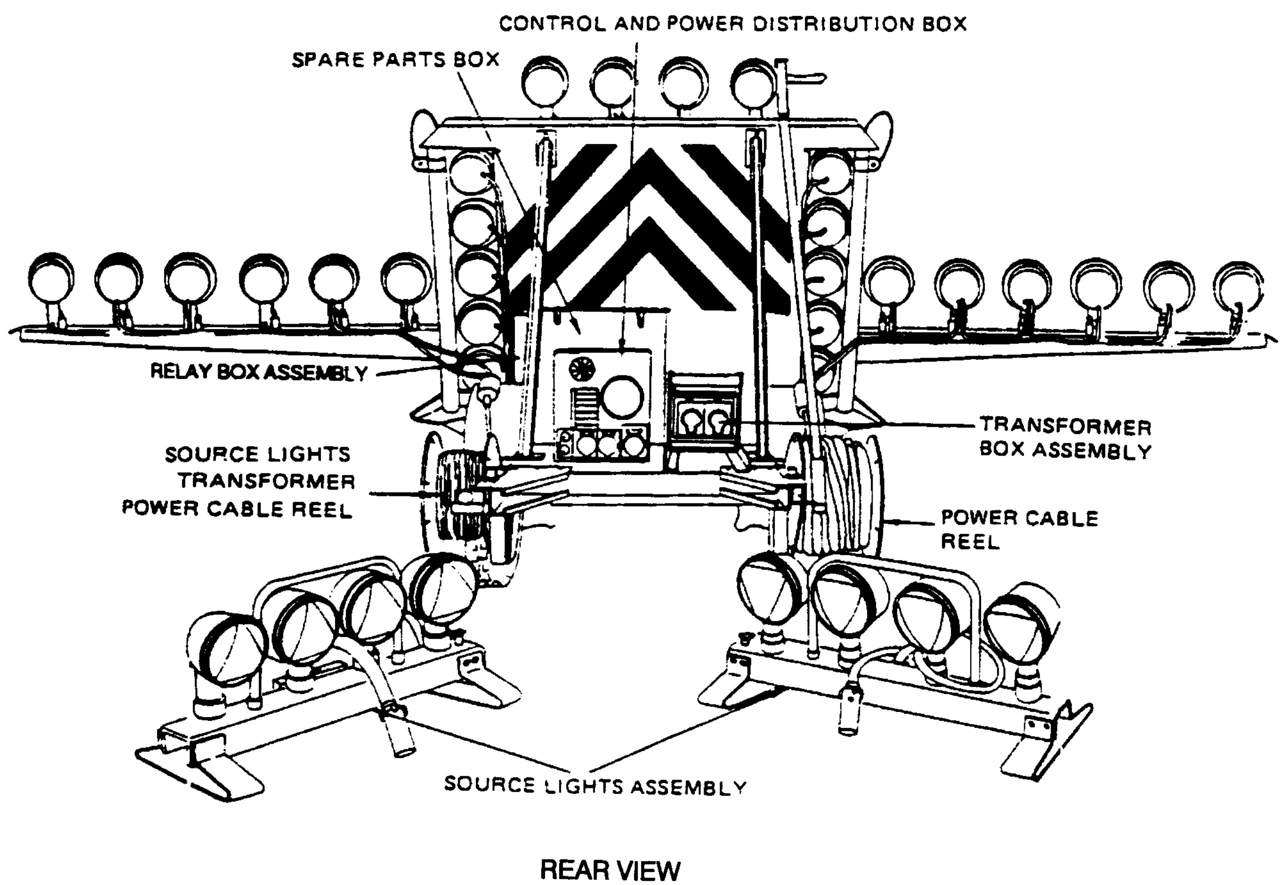
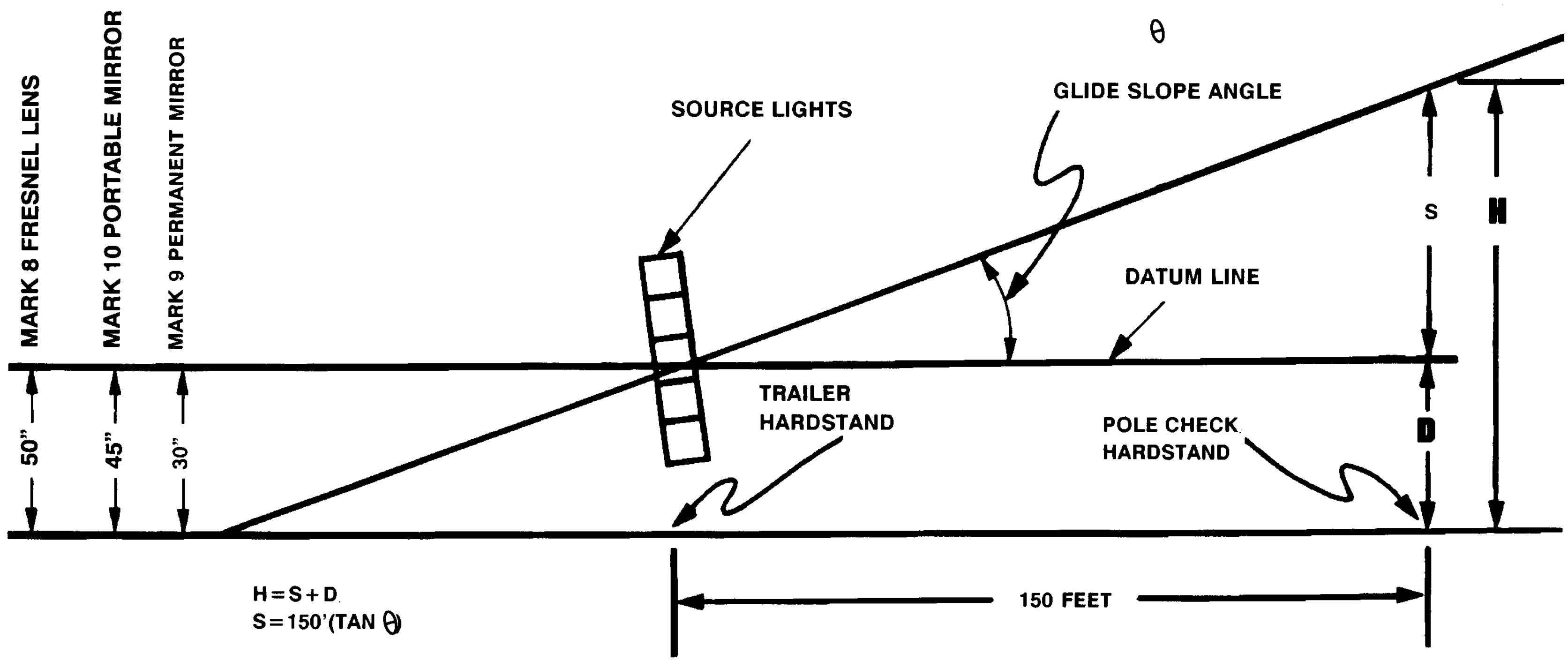


Figure 11-6 Mk 10 Mod 0 Mirror Optical Landing System

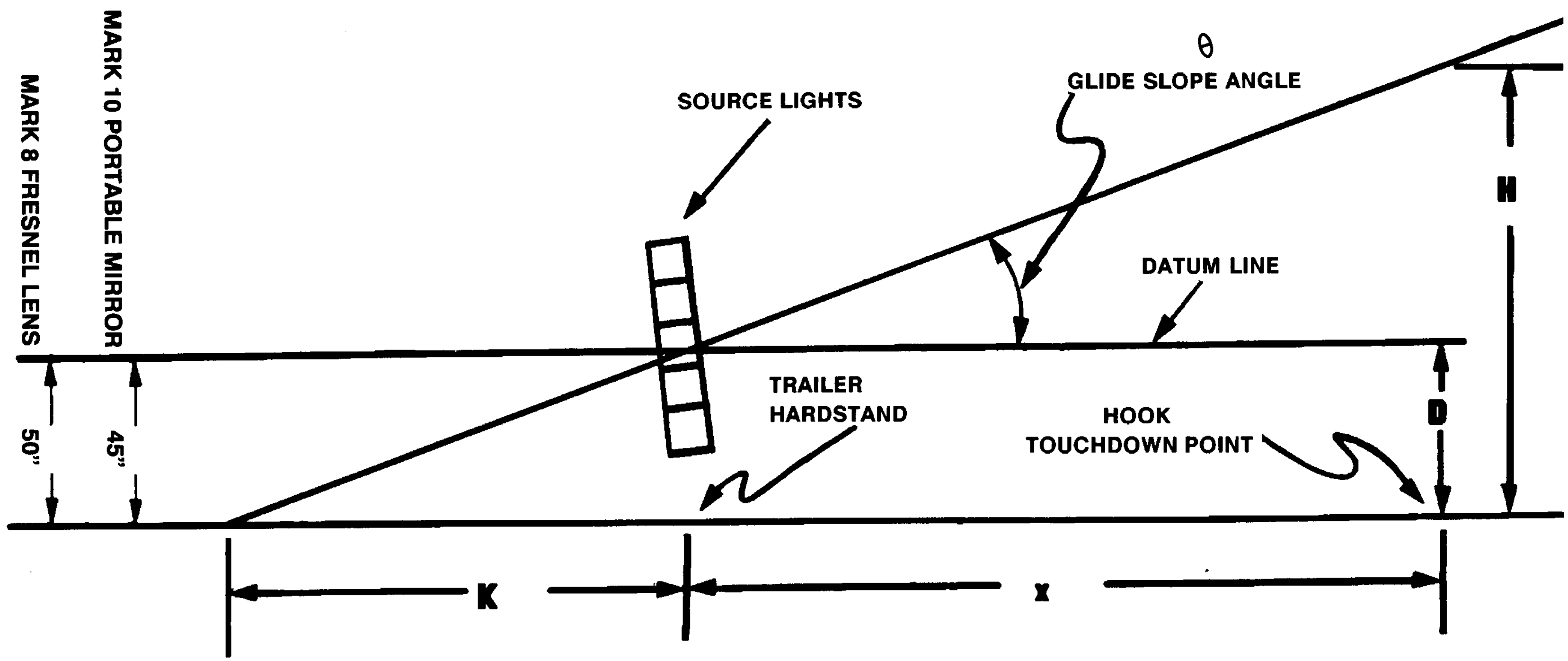


GLIDE SLOPE ANGLE	TANGENT	POLE CHECK HEIGHT "		
		MK 8	MK 10	MK 9
3	.05241	144	139	124
3.25	.05678	152	147	132
3.5	.06116	160	155	140
3.75	.06554	168	163	148
4	.06993	176	171	156

NOTES:

1) S=pole check height above the datum lights. S is a constant for all optical landing aids at a given glide slope angle.
2) H=the distance between the deck and the pole check mirror.
3) D=datum light height above the trailer hardstand.
4) Trailer and pole check hardstand must be the same elevation.
5) Tolerance: ±1"

Figure 11-7 Pole Check Heights for Shorebased Optical Landing Aids



$$X = \frac{H}{\mathrm{TAN}\,\theta} - K$$

$$K = \frac{D}{\mathrm{TAN}\,\theta}$$

$$X = \frac{H}{\mathrm{TAN}\,\theta} - \frac{D}{\mathrm{TAN}\,\theta}$$

Figure 11-8 Hook Touchdown Points for Shorebased Optical Landing Aids

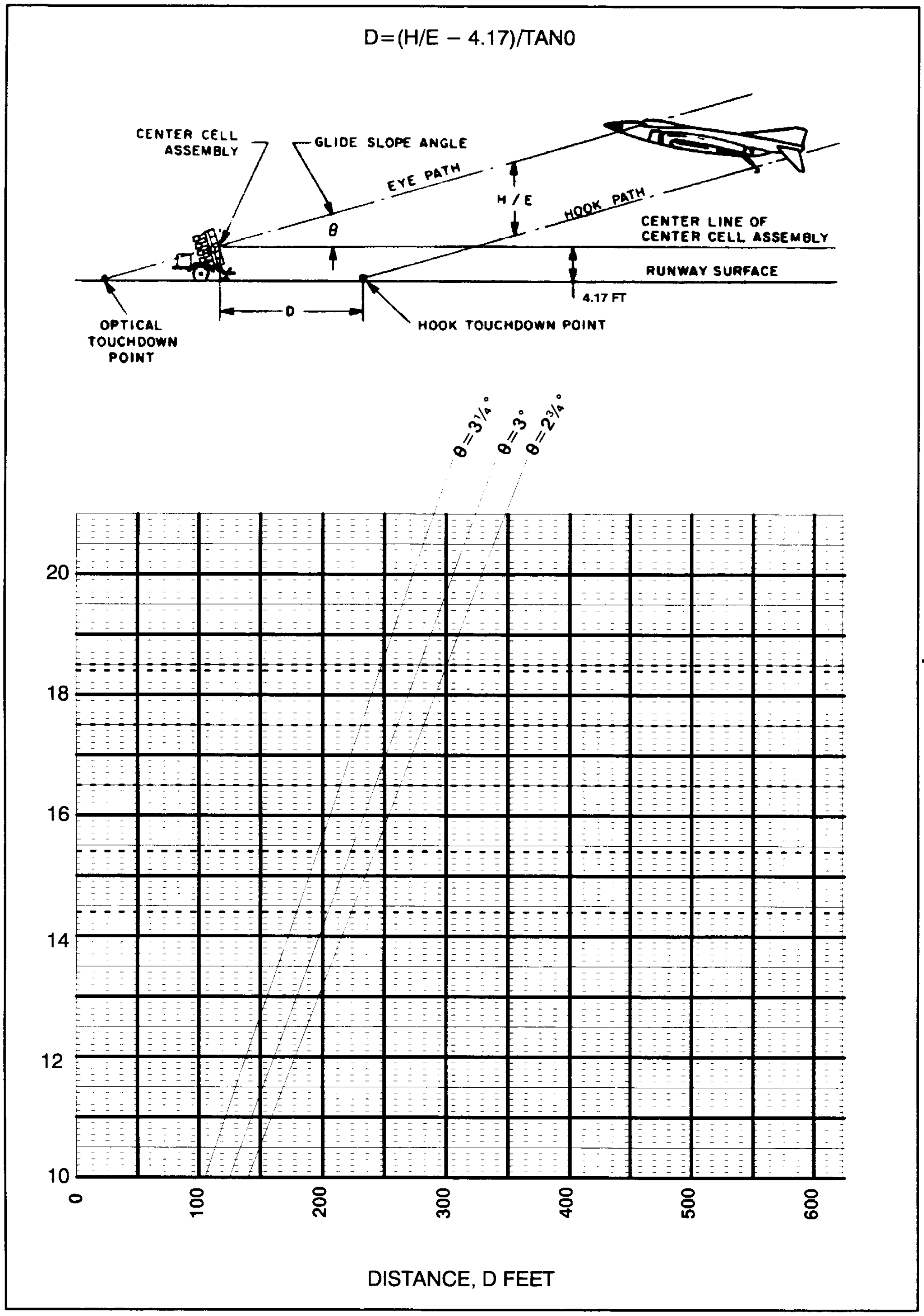


Figure 11-9 Hook-to-Eye / Touchdown Point Chart (Mk 8 Mod 1)

CHAPTER 12

SHOREBASED/FIELD ARRESTING GEAR

12.1 GENERAL

The purpose of shorebased emergency runway arresting gear is to provide a safe and efficient means to recover tailhook equipped aircraft that may have to abort a takeoff or cannot make a normal landing.

The two basic types of arresting gear used by the Navy ashore today are:

1. Mass - E-5 Chain weight and friction.

2. Hydrodynamic Braking

   (a) E-28 Turbulent Fluid Resistance

   (b) M-21 Vortex Principle and metered fluid flow

Except for the M-21, arrestment of the aircraft is entirely automatic.

12.2 E-5 CHAIN GEAR

E-5 Chain Gear is currently utilized as an overrun arresting system at some air stations. The emergency chain arresting gear consists of two arresting cables spaced 30 feet apart, stretched across the runway with ends connected to a 3-way coupling. Predetermined lengths of anchor chain are secured to the 3-way couplings by means of "D" ring connectors and laid along the inboard edges of the runway (overrun) in the direction of aircraft arresting hook engagement. Tensioning pendants, installed to keep the cables taut, are fastened to anchors at one end and the arresting cables at the other end.

The arresting cables, when engaged by the aircraft arresting hook, transmit the energy of the moving aircraft to the two anchor chains. The arrangement of the chains allows them to pay out gradually, progressively increasing the weight pickup. The energy is dissipated by the gradual weight pick-up until arrestment is complete.

12.2.1 Models of E-5 Chain Gear. The E-5 Mod 0 "Straight Pendant" basic chain arresting gear is shown in *Figure 12-1*. The chain weights are arranged so that the heaviest chain is at the far end.

12.2.1.1 E-5 Mod 1. The E-5 Mod 1 "shaped pendant" *(Figure 12-2)* consists of two cables of different lengths, due to the shaped configuration. The tensioning pendants are attached to the "D" ring instead of the cables. This arrangement maintains tension throughout the length of the cables thereby allowing for a higher engaging speed.

12.2.1.2 E-5 Mod 3. E-5 Mod 3 chain gear, rarely used today, is primarily for midfield applications, but may also be modified for use as overrun gear.

12.2.2 Capabilities and Limitations.

Engagement direction: Uni-directional

Weight limit: None

Engaging Speed: E-5-0, 150 knots
E-5-1, 165 knots

Off-center engagement: As per aircraft NATOPS but not more then 1/4 of the runway width

Cycle time: 3-4 hours

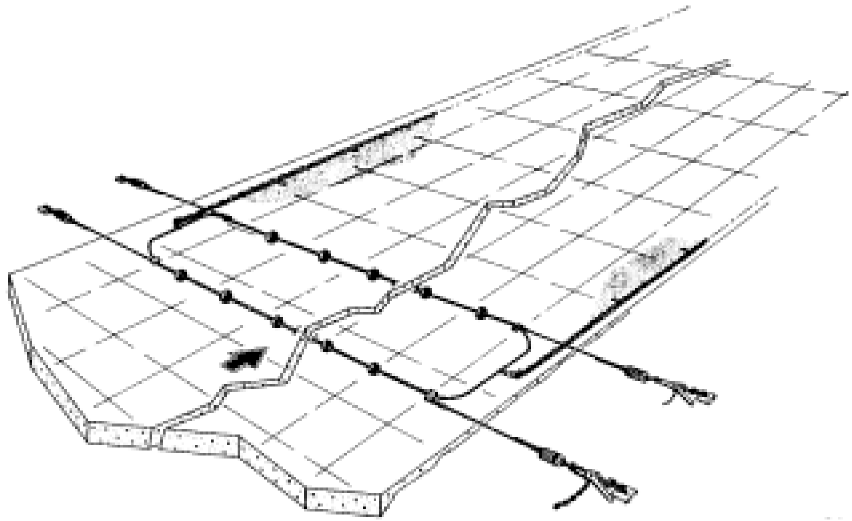


Figure 12-1 E-5 Mod 0

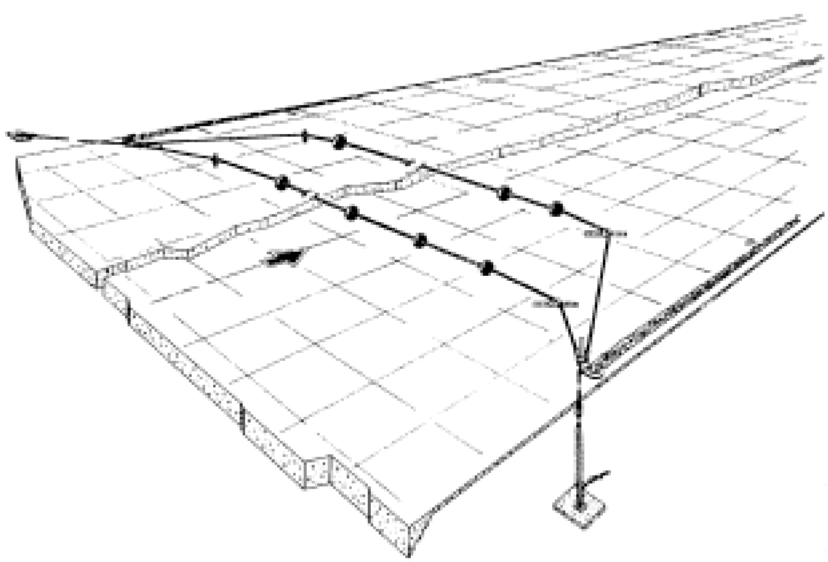


Figure 12-2 E-5 Mod 1

12.3 E-28 Turbulent Fluid Resistance Operation

The E-28 arresting gear installation consists of two arresting engines installed above deck on opposite sides of the runway and each operating a single nylon tape. The tape from each engine is routed through a deflector sheave, a runway edge sheave assembly and is coupled by means of a tape connector to one end of the deck pendant. The two arresting engines are rotary hydrodynamic energy absorbers and are designed to jointly dissipate the kinetic energy of a landing aircraft. The arresting engines are installed outside the edges of the runway *(Figures 12-3 and 12-4).*

The arrestment is entirely automatic. The arresting gear is activated when the aircraft arresting hook engages the deck pendant, thereby pulling out the attached purchase tapes. As each tape unwinds, the drum, through the splined shaft, turns a vaned rotor between vaned stators in a housing filled with fluid. The turbulent fluid resistance decreases the rotational speed of the drums, thereby slowing down the purchase tape payout which in turn applies a braking force on the aircraft. The ensuing fluid turbulence converts the aircraft's kinetic energy into heat.

2.3.1 Arresting Engine Components. The major components of the arrestor engine are a tape drum and capstan assembly, a retrieve drive sprocket and bearing assembly, a vaned rotor mounted on a common shaft assembled in a vaned housing.

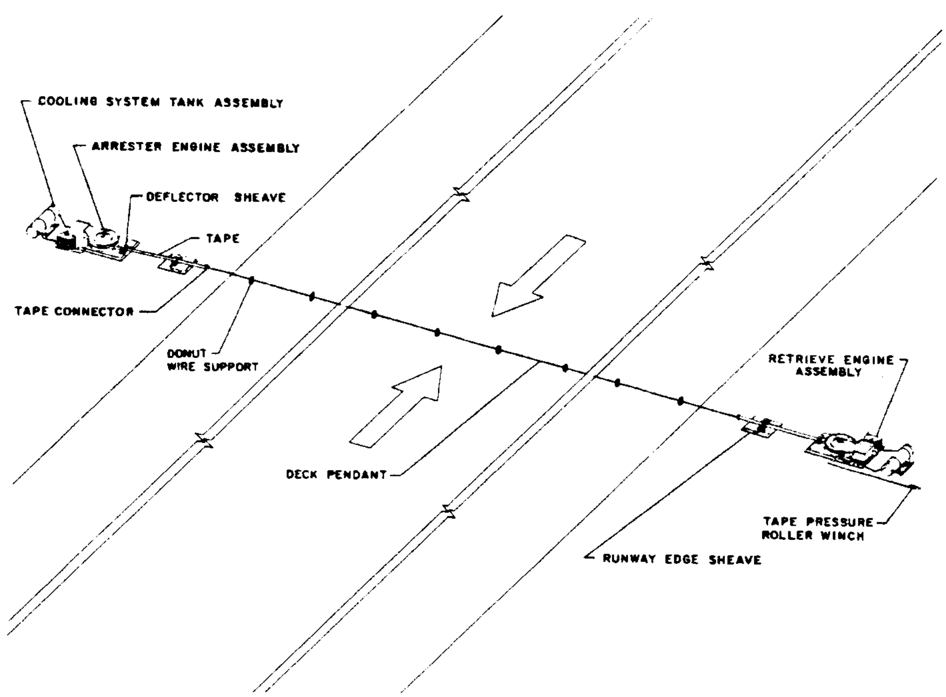


Figure 12-3 E-28 Installation

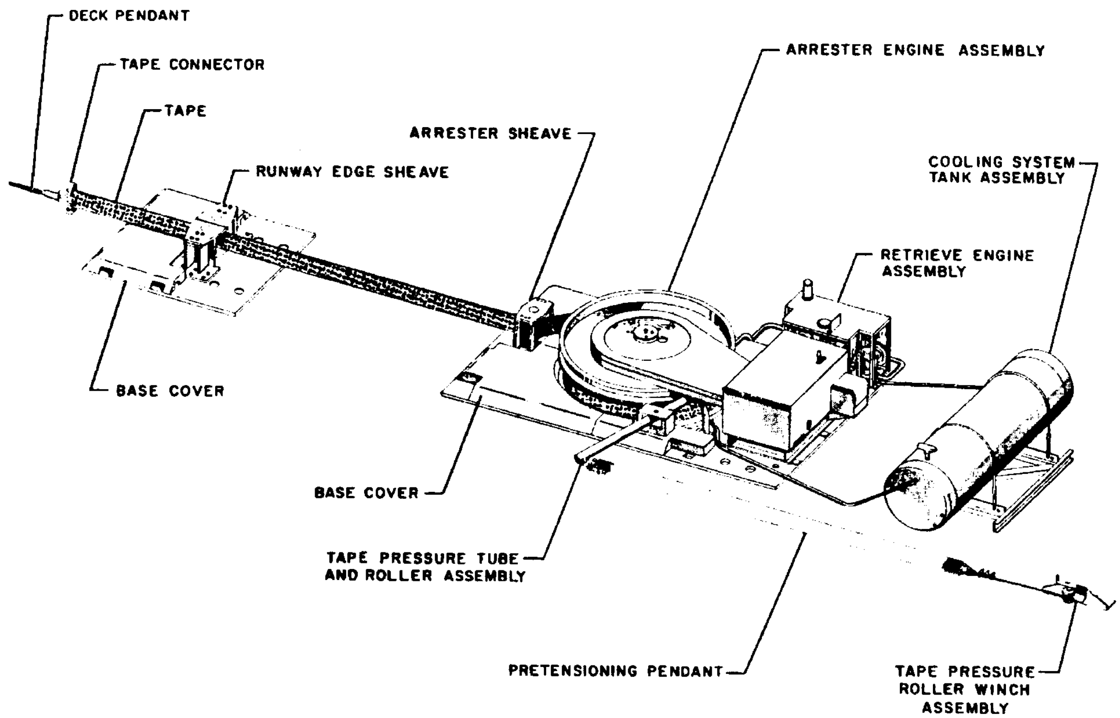


Figure 12-4 Engine Assembly (E-28)

12.3.1.1 Energy Absorber. The energy absorber unit is mounted on a steel base on which are also mounted a retrieve engine, an arrestor sheave and a tape pressure arm pivot. When the splined tape drum and splined rotor are assembled on the shaft they function as a unit. During an arrestment the tape drum drives the rotor whose motion is resisted by the turbulent fluid in the housing, thus decelerating the tape drum. A retrieve drive sprocket assembly is bearing mounted on the shaft, above the tape drum. At the beginning of an arrestment the retrieve system is automatically disengaged from the tape drum through the action of the cam release post acting against the automatic release mechanism. This allows the tape drum and rotor to run free of the sprocket assembly. Following arrestment, the retrieve system is manually engaged to the tape drum through contact of the armed, spring loaded cam on the cam release post. The sprocket is chain driven by the gasoline engine which is the power source for rewinding the tape back onto the drum.

12.3.1.2 Retrieve System. The retrieve system consists of a gasoline engine with a 12-volt starting system, a torque converter with a front disconnect clutch, and a speed reducer with a duo-cam clutch, operated from a control panel mounted on the retrieve assembly base.
The function of the retrieve assembly is to rewind the tape and pretension the pendant after each arrestment *(Figure 12-5)*.

12.3.2 Capabilities and Limitations.

Engagement direction: Bi-directional

Engaging speed: varies with aircraft weight according to type of arrestment (short field/long field/aborted take-off). Should not exceed 180 knots.

Off-center engagement: varies but not more than 40 feet

Normal run-out: 900-950 feet

Cycle time: 80-90 seconds

There is a waiting time of 90 seconds between arrestments utilizing the E-28 arresting gear provided the crew is standing by and after the post arrestment check nothing is wrong.

Brakes should be applied when speed is reduced to 20 knots to reduce the possibility of two-blocking of gear and bounce back.

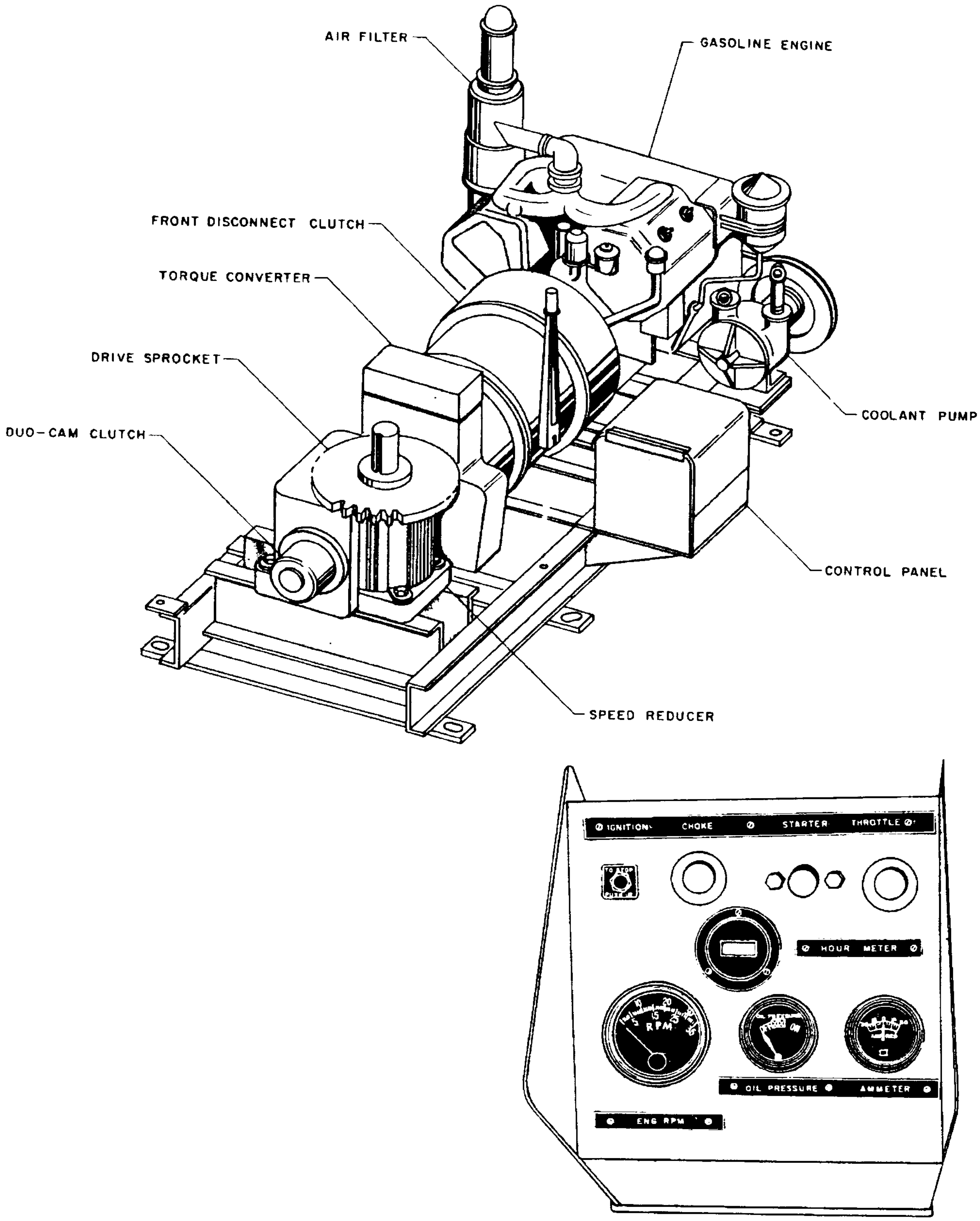


Figure 12-5 E-28 Retrieve System and Control Panel

12.4 M-21 EXPEDITIONARY AIRCRAFT RECOVERY SYSTEM

The M-21 Primary Recovery Installation *(Figure 12-6)* is a lightweight, high-capacity arresting system for the recovery of aircraft at an expeditionary air field site under normal arresting conditions. Recovery of aircraft is accomplished through a pair of arrester engine assemblies (energy absorbers) which are connected by a deck pendant.

12.4.1 Installation. The arrester engines utilize the vortex principle of energy absorption in a hydrodynamic braking system. The principle of operation is as follows: As the arresting hook of an incoming aircraft engages the deck pendant, which is pre-tensioned across the runway and connected to tapes on the arrester engines, the tapes unwind to set the absorber rotor of each arrester engine in motion. Rotation of the rotor sets fluid in the base of the arrester engine into motion, causing the fluid to flow toward and around the outer periphery of the rotor at great velocity and developing vortex action at the center of the rotor. This flow is diverted to the absorber stator which decreased the velocity and causes the flow to enter the vortex action of the fluid.

As fluid motion increases, due to the rapidity of tape removal, the greater is the braking action. The rate of flow of the fluid through the absorber, for a specific aircraft weight and engagement speed, is controlled by a throttle in the base of the absorber. At completion of an arrestment, a friction brake within each arrester engine *(Figure 12-7)* retains the tape reel in the unwound condition, to allow disengagement of the deck pendant from the aircraft's arresting hook. The friction brakes are released and the tape is rewound onto its respective reel. Each reel is powered by a separate engine assembly.

12.4.2 Capabilities and Limitations.

Engagement direction: Bi-directional

Engaging speed/weight: IAW recovery bulletin 45-12

Runout: 765 feet maximum

Cycle time: 20 seconds minimum.

* Requires a separate throttle setting for each type of aircraft.

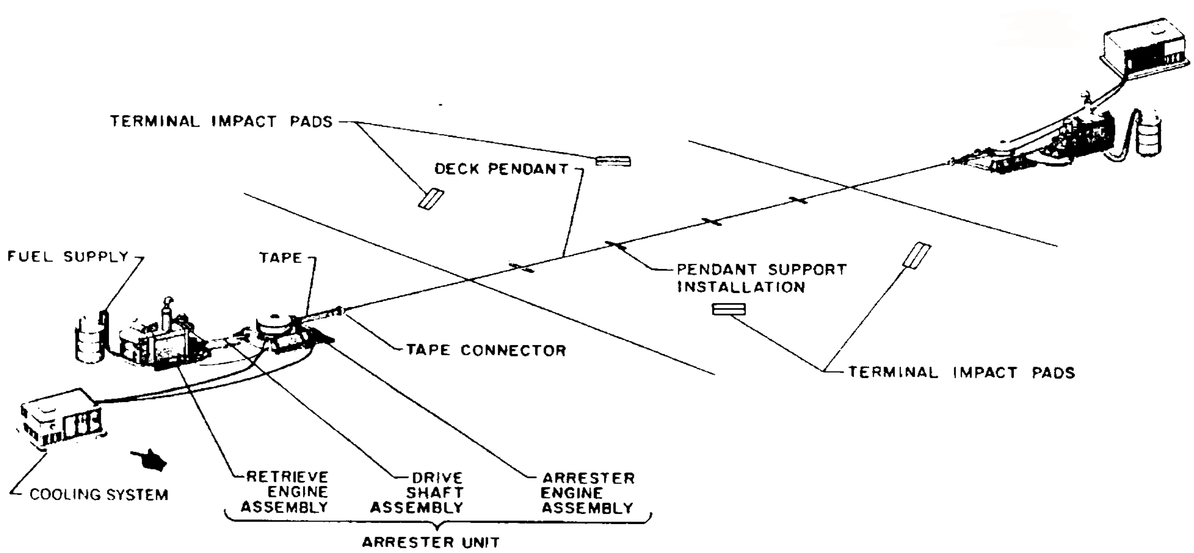
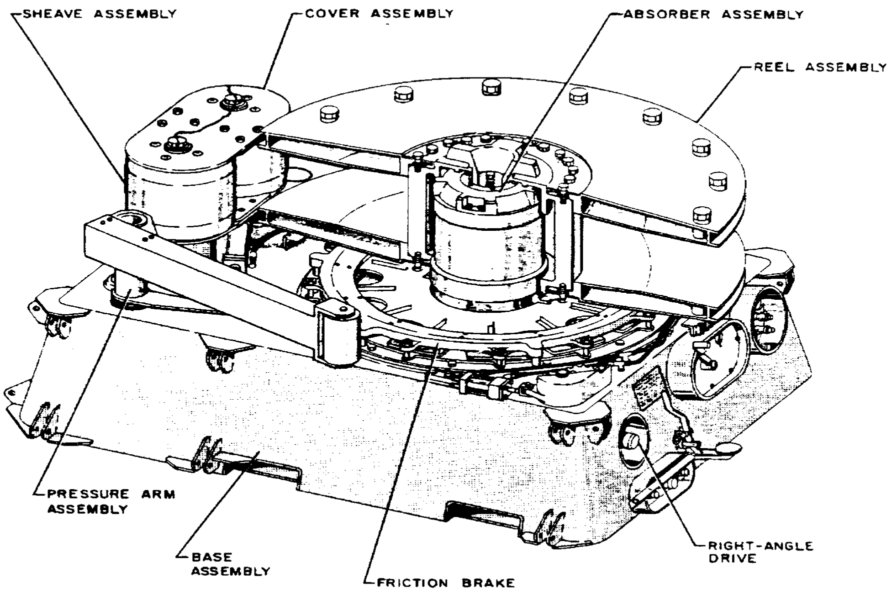


Figure 12-6 M-21 Installation



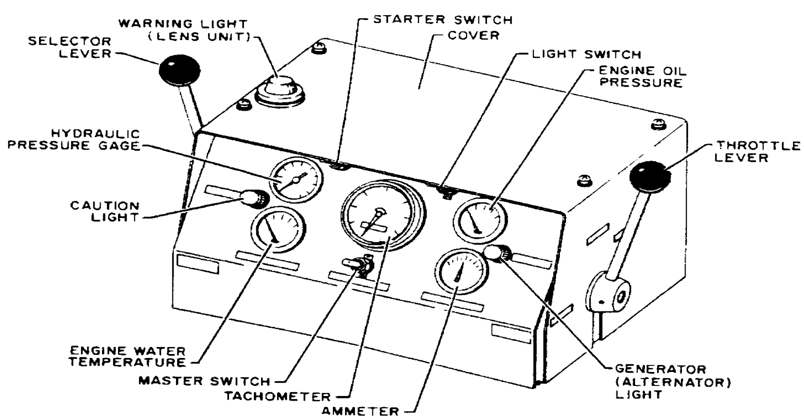


Figure 12-7 M-21 Engine Assembly and Control Panel

12.5 U.S. AIR FORCE RECOVERY EQUIPMENT

The following is a list of all Air Force recovery equipment, as compared to the Navy equipment:

MA-1A: Web barrier between stanchions attached to a chain energy absorber designed primarily for main strut engagement. No Navy equivalent.

MA-1A Modified or MA-1/E-5:
Same as MA-1A but has an additional pendant 36 feet in front of the barrier for tailhook aircraft. The barrier is normally lowered and the tower operators must be told that a barrier engagement is desired, normally 15 minutes prior to engagement.

BAK-9 Rotary Friction Brake. No Navy equivalent.

BAK-12 Rotary Friction Brake.
No Navy equivalent. Three types are: Standard (950' run out), Extended (1200' run out), and Dual (two energy absorbers at each side of runway connected to single cable).

MA-1A/BAK-9, BAK-12 Also known as BAK-9 and MA-1A interconnect, it is a web barrier between adjustable stanchions combined with a hook pick-up cable and a mechanical energy absorber.

BAK-14 The BAK-14 is a retractable hook cable support system used in conjunction with the BAK-12 (or other comparable system). The hook cable is recessed beneath the runway and raised or lowered by remote control from the tower. The system requires up to 5 seconds to fully raise the cable.

CHAPTER 13

SHIPBOARD ORGANIZATION

13.1 ORGANIZATION

As an LSO you work with both the Air Wing and the Air Department. The Air Department Head is the Air Officer (Air Boss) who controls all air operations within 5 miles of the ship.

Most of your contact will be with the "Boss," but his divisions *(Figures 13-1 to 13-3)* can also provide services for you.

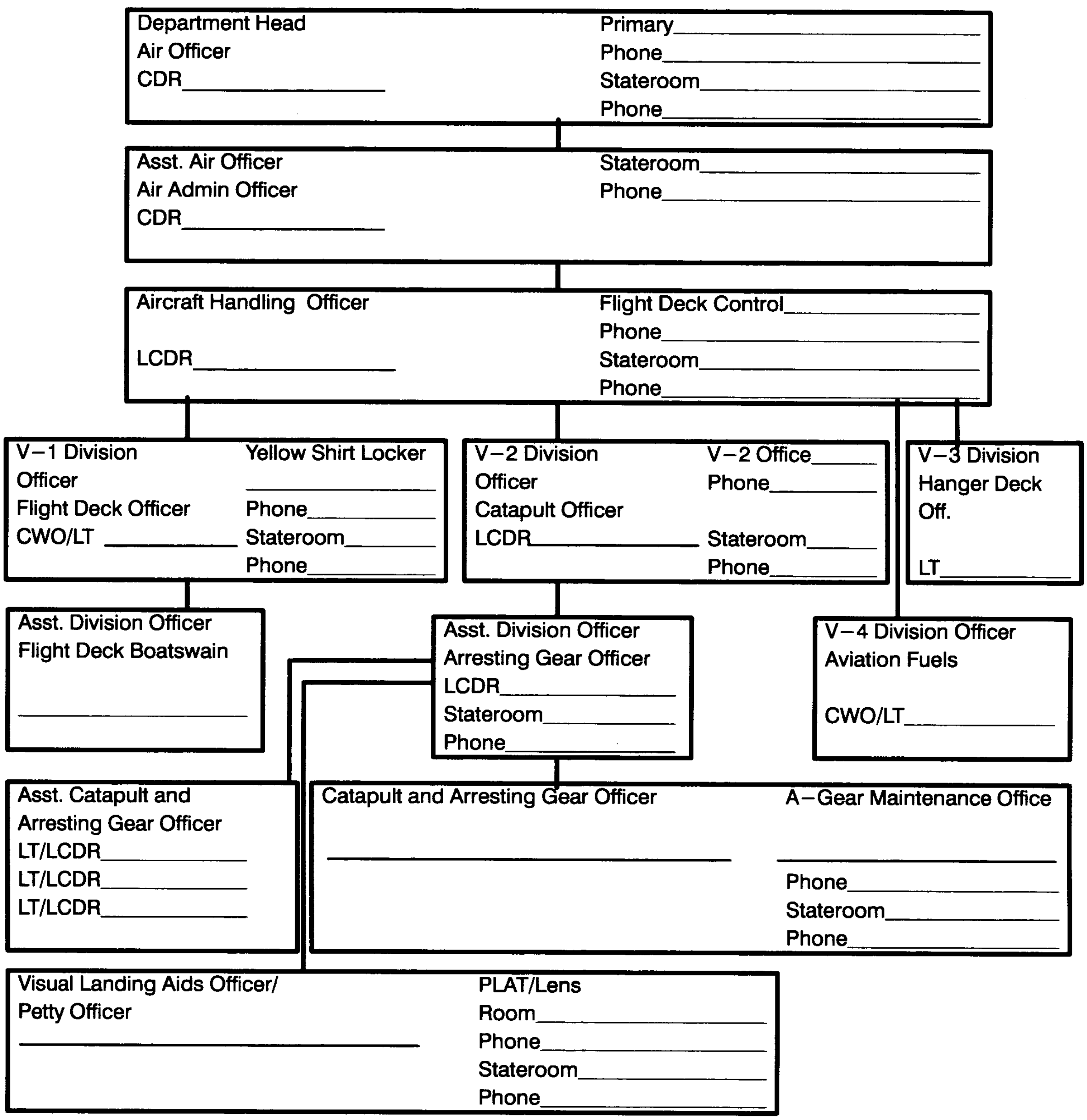


Figure 13-1 Air Department Personnel

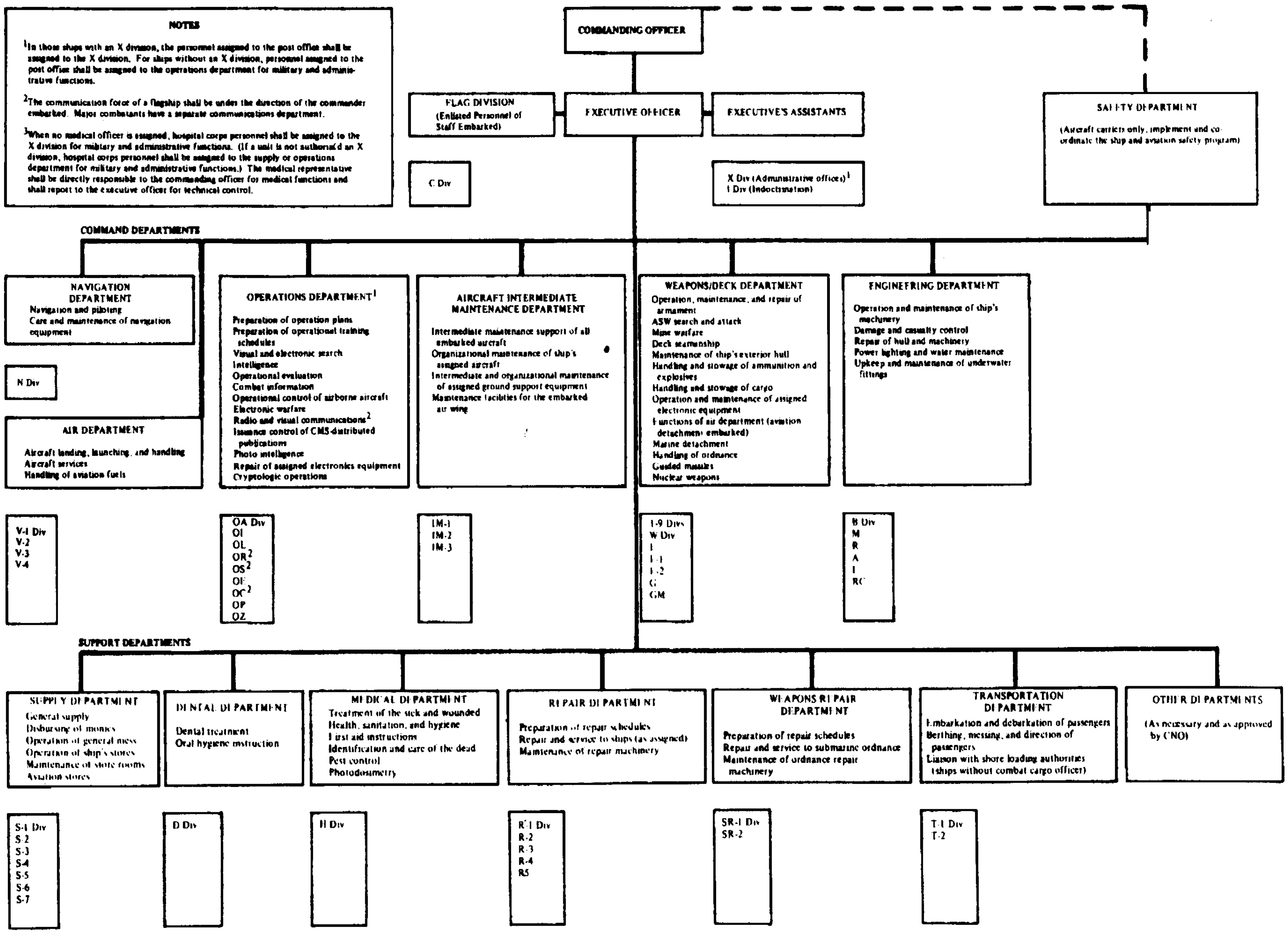


Figure 13-2 Shipboard Organization

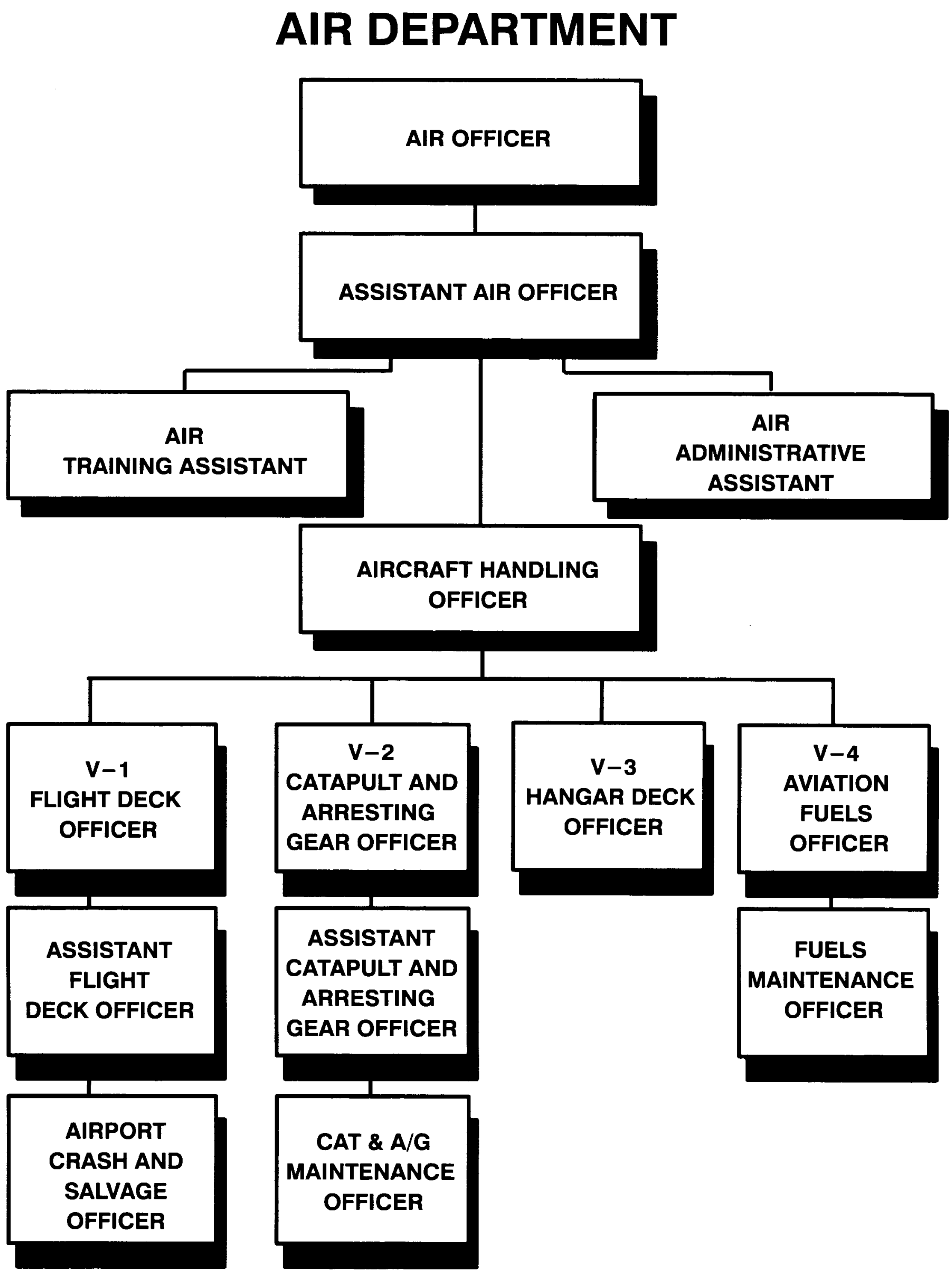


Figure 13-3 Air Department Organization

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CHAPTER 14

Carrier Air Traffic Control Center (CATCC)

14.1 GENERAL

CATCC is responsible for the coordination and control of airborne aircraft. The Air Operation workstation coordinates the planning, supervision, and status-keeping of carrier aircraft. CATCC controls all carrier airborne aircraft, except those aircraft under the control of the Combat Direction Center (CDC), or the Air Officer.

14.2 RESPONSIBILITIES

CATCC, under the direction of Air Operations officer, controls aircraft during launch and recovery operations. Normally, control is exercised within the Carrier Control Area, which is a circular airspace extending about the carrier for a radius of 50 nautical miles and from the surface to infinity. During Visual Meteorological Conditions (VMC) control of flight is transferred by CATCC to the Air Officer when aircraft enter the Carrier Control Zone, which is a circular airspace extending about the carrier for a radius of 5 nautical miles and extending from the surface to 2500 feet. The Landing Signal Officer (LSO), under supervision of the Air Officer, controls aircraft in the terminal phase of the approach immediately prior to landing.

14.3 ORGANIZATION

CATCC is under the direction of the Air Operations Officer who, in turn, is under the direction of the Operations Officer. The Air Operations Officer is assisted in the direction of CATCC by other Officers and Petty Officers. *Figure 14-1* shows the CATCC functional organization, which represents the basic functions performed in CATCC during launch and recovery operations. Other personnel are required to support these functions; for example, other enlisted personnel are required to exchange information between CATCC and other work stations, and to record needed information. the number of other personnel required will vary from carrier to carrier, and with the type of flight operations being conducted.

Operations Department
(CATCC)

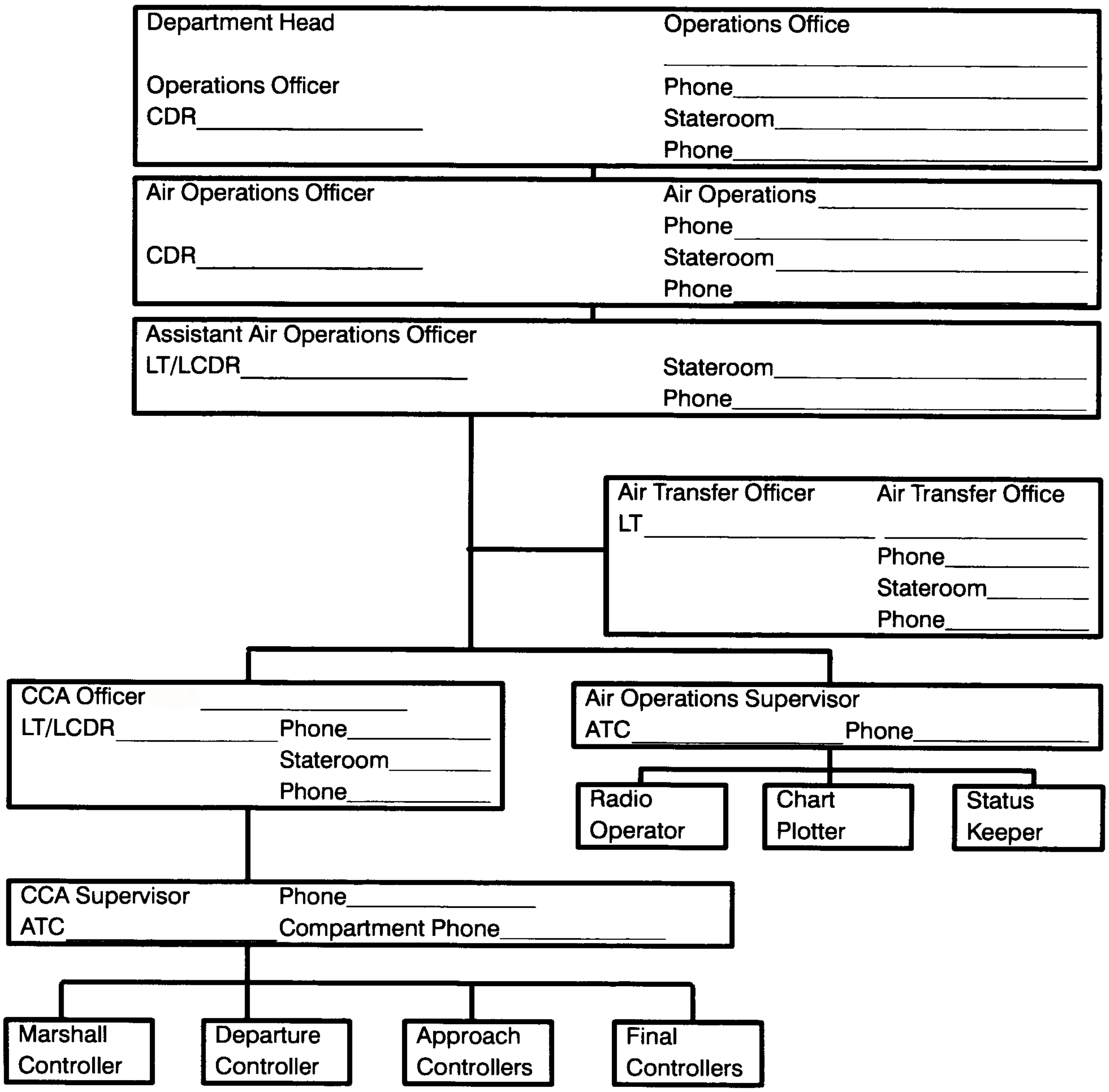

Figure 14-1 Operations Department (CATCC) Personnel

CHAPTER 15

THE AIR PLAN

15.1 GENERAL

The Air Plan is published daily by the Operations Department and is the basis by which individual squadron flight schedules are published. Standard Air Plan information is listed in the CV NATOPS. Since the Air Plan lists all scheduled air operations and missions, it is important that duty LSOs are familiar with its contents.

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CHAPTER 16

AIRCRAFT LIGHTING

16.1 GENERAL

This section contains information on carrier aircraft light configuration.

16.2 LIGHTING CONFIGURATION

16.2.1 Approach Lights. All carrier aircraft have an angle of attack system installed with a multi-colored external approach indexer which provides LSOs with aircraft attitude/speed trends.

Green - slower than optimum

Yellow - on-speed

Red - faster than optimum

The limit for on-speed indications varies with each individual aircraft, but normally covers a three to six knot speed range. On all aircraft only one indexer is illuminated at a time. Generally, illumination of the indexer gives some indication that the landing gear is down and locked (see individual aircraft for system requirements). Note that other external lights may be mistaken for approach lights, such as glove vane lights on an F-14. Due to improper configuration or an angle of attack malfunction, the display of an amber approach indexer does not assure that the aircraft is at optimum speed or attitude for arrestment.

16.2.2 Aircraft Indexers. Most newer aircraft have the indexer located so as to give light symmetry; i.e., the indexer is located at the midpoint between wingtips, and can thus provide crude aircraft heading information to the LSO. Additionally, when some aircraft are on speed, wingtip navigation lights and the approach indexer form a horizontal line. Light asymmetry makes aircraft lineup and drift less discernible and makes distance from touchdown harder to determine, especially when one or more external lights are inoperable.

16.2.3 Light Configuration. Light configuration is extremely important for aiding the LSO in control of aircraft at night. Inadvertently turning on the taxi light, or the external lights master switch off, incorrect approach light day/night position, forgetting to secure anti-collision lights, or inoperative external lights can adversely affect LSO performance. The more the normal external light configuration is degraded, the more the visual cues become misleading, subsequently degrading LSO control. The LSO should avoid the tendency to fixate on a single light particularly while controlling aircraft with inoperative external lights, and should be aware of the effects of autokinesis. A moving scan by the LSO can aid in minimizing these effects.

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CHAPTER 17

ENVIRONMENTAL FACTORS

17.1 GENERAL

An analysis of past carrier landing mishaps has shown that over 25% of causal factors were environmental in nature. Pitching deck was the single most influential factor, involving 15% of all mishaps. The next most influential factor was "no horizon", or a black night, which was related to over 5% of mishaps. Other environmental factors contribute to lesser degrees.

17.2 ENVIRONMENTAL FACTORS

The LSO is responsible for making instantaneous judgement decisions concerning aircraft approach acceptability while taking into account numerous considerations. There are many environmental factors which affect the safe approach and landing of carrier aircraft. Of these environmental factors, recovery winds, ships pitch and heave are the most critical elements in making accurate predictions of safe landing parameters. While others affect an aircraft recovery to a lesser degree, LSO familiarity with all environmental factors is essential knowledge.

17.2.1 Optimum Recovery Headwind. Recovery headwind (RHW) is the component of wind over the deck which is parallel to the landing area centerline. Twenty-five (25) knots of recovery headwind is considered optimum for aircraft shipboard recovery. Other than optimum wind conditions produce various associated effects on approach parameters and LSO control considerations. To provide for the safest aircraft approach conditions, 25 knots of recovery headwind optimize the following considerations:

Aircraft flying characteristics

Engine response time

Maximum arresting gear engaging speeds

Approach speeds

Maximum allowable rate of descent

Pilots forward field of view

Control in the event of an engine failure

Waveoff capability

Pilot response time

LSO response time

17.2.2 Burble. Disturbance in the air mass flow as it moves upward over bow or angle deck, along the landing area, down at the ramp and reflecting off the water is unique to carrier operations and is depicted in *Figure 17-1.* The resultant airflow aft of the ramp is termed the burble. The magnitude and position of the downdraft/updraft aft of the ramp is a factor of the air mass velocity and ships forward motion. Carriers with a large island superstructure produce the most severe burble.

The burble directly affects an aircraft approach by causing a sudden increase in lift in the middle then a decrease in lift in close to at the ramp. A pilot correcting for more lift in the middle with a power reduction will need to anticipate the recorrection needed for the loss of lift in close. Also, pilot awareness is critical during lineup corrections while being affected by the burble. The burble effect is minimized with optimum recovery headwind.

17.2.3 High Recovery Headwinds. Higher than optimum winds may be encountered as a function of the natural wind and/or required carrier speed. Effective glideslope, power required and resultant change to glideslope basic angle setting are the factors affected to the greatest degree by high winds. If the WOD is in excess of 35 knots a 3.75 degree basic angle and if in excess of 40 knots a 4.0 degree basic angle is recommended for ships that normally use a 3.5 degree basic angle.

Pilots will have to deal with a more significant burble located closer to the ramp and be at a higher stabilized power setting throughout the approach. There will be greater turbulence in close and potential for wing drop at the ramp and beyond. Higher sink rates will develop from relatively small power corrections, decreasing the bolter rate but increasing the chance of early wires. Gust responsive aircraft will have more problems maintaining good glideslope parameters. The lineup parameter will be affected if the pilot and LSO fixate on glideslope. Finally, attention must be given the Case I pattern as an earlier than normal turn in point will be required to avoid being long in the groove.

17.2.4 Low Recovery Headwinds. Lower than optimum winds may be encountered as a function of the ship's inability to make way combined with low natural winds. Under low wind conditions, higher closure rates affect the aircraft's power setting, waveoff window, and maximum engaging speed limits. Higher closure rates also yield less time for glideslope or lineup corrections. The rate of descent to maintain a commanded glideslope is greater and effective glidepath is steeper, affecting landing gear structural limits. With low wind over the deck, the burble is weaker and farther aft in the groove. Sink rates will be reduced with smaller power additions, thus lowering boarding rate. Finally, a later turn in point will be required in the Case I pattern.

17.2.5 Crosswinds. The affects of port and starboard crosswind are similar. Aircraft Recovery Bulletin 10-10 delineates a maximum crosswind component of 7 knots at 90 degrees for all carriers. Lineup control is the biggest problem for the pilot and LSO. More significant drift coupled with ship turns for wind correction create greater approach deviations, especially for gust responsive aircraft. Crosswinds tend to keep the burble stronger and closer to the ramp. For any given wind speed, the headwind component is less than in a pure headwind, so the sink rate at landing is increased. Due to problems in dealing with the burble and late lineup corrections, the bolter rate will increase. With a significant starboard crosswind, island "blanking" will occur in the landing area which can lead to a drift in close and increased sink rates at the ramp. The AOA/airspeed parameter is most directly affected by scan breakdown and AOA transients in gusty conditions.

Crosswind from left of the angle is port or slightly port, that from down the angle to down the bow is slightly axial to axial, and that from right of the bow is starboard or slightly starboard.

Indicated wind in knots	Crosswind angle relative to angled deck
40	± 10°
35	± 11°
30	± 13°
25	± 16°
20	± 19°

Adverse aircraft landing performance or rollout could occur prior to reaching the limits above.

17.2.6 Turbulence. Turbulence is air mass disturbances most often associated with that occurring as a result of high natural winds. However, turbulence sources also include irregular upwash and downwash from aircraft launching on the bow, airflow around the island structure, yellow gear and aircraft on the flight deck, and jetwash. Affects are random wing drop on landing, increased sink rates, and subsequent higher landing gear loads on touchdown. These problems have an even greater effect on slower moving, light wing loaded, gust responsive aircraft.

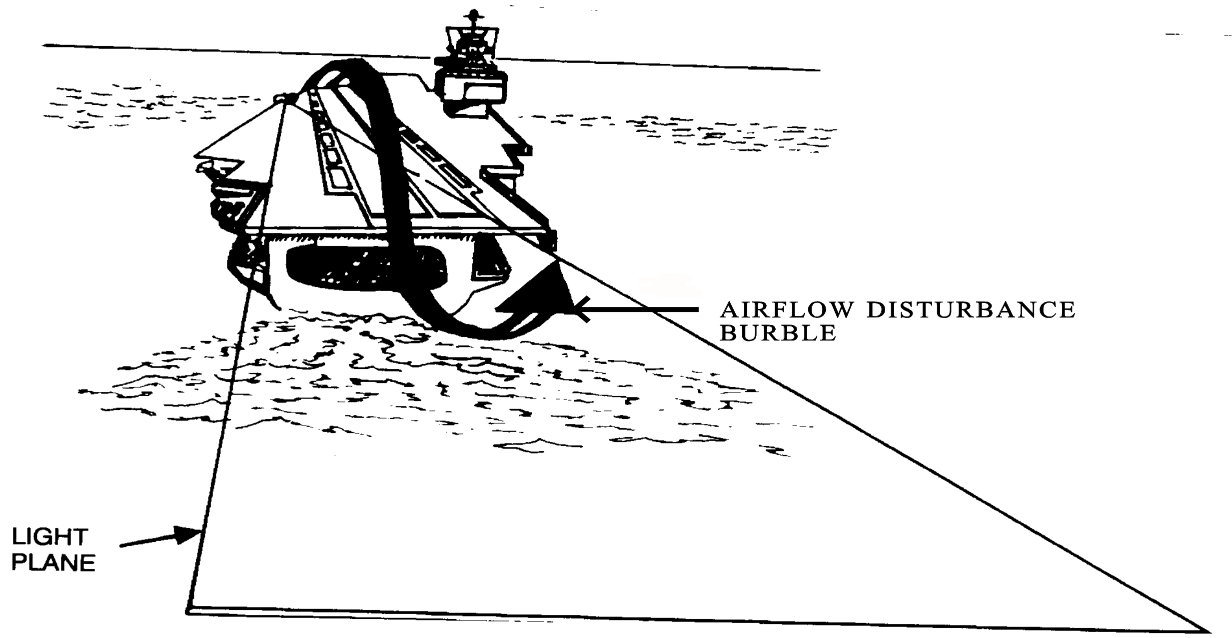


Figure 17-1 Burble Location

17.2.7 Downwind Recovery. Downwind recoveries may occur due to sea room restriction or other ship's requirements. The Case I pattern will be the opposite of normal. Aircraft will be flying into a headwind while on the downwind leg, necessitating an extension off the abeam in order to get sufficient groove length. There may also be a pattern crosswind situation which will require attention. In this situation, the ship will be making the WOD, yielding axial winds. Aircraft must be flown with particular attention to maintaining on speed and the LSO must ensure the maximum engaging speeds are not exceeded. Being back on the power, engine response may be slower, dictating a change in the position of the waveoff window. Because of increased burble affects early wires can be expected.

17.2.8 Pitching Deck. Deck pitch due to sea state is difficult to predict and causes numerous safety concerns for the LSO and pilot. Care must be taken to ensure that aircraft are waved off in a timely fashion if out of phase with the deck approaching the waveoff window. As the deck pitches, it dwells longest at its maximum up/down excursions. Deck pitch normally has a characteristic ten second cycle, however, occasional hesitation or random periods of steady deck may occur.

17.2.9 Heave. Natural heave occurs as result of variation in the force of buoyancy from greater to less than that of gravity; the ship bobs up and down. Heave is less predictable than pitch but rarely exceeds 5.5 feet.

See section 7 of Aircraft Recovery Bulletin No. 10-10 for detailed discussion of recovery winds.

17.3 HORIZON REFERENCES

Like the pilot, the LSO requires some visual reference in order to judge aircraft position/attitude. Ideally, a wide horizon is available i.e., daylight, moonlight or shore lights. As the aircraft approaches the ramp aircraft light reflections off the water can be used. The use of the ramp as the only reference is least desirable, especially when it's moving. Artificial horizon may be created by positioning the plane guard destroyer at approximately 2000 yards aft on the final bearing. If not available, plane guard helo may be placed 3 nautical miles aft at 100 to 200 feet. Should the helo be unavailable, sea marker flares may be utilized.

The inability to judge approach geometry is most critical when waving approach-light only aircraft. When viewing a single light source autokinesis causes apparent movements of the light source with no actual movement. With a horizon reference, rough glideslope cues may be available; however, judging distance from touchdown is critically degraded. This may prevent the LSO from establishing a safe waveoff point. Reliance on HUD SPN-42 ranging information in this situation may minimize this hazard.

17.4 Effects of Wind Summary Chart.. A summary of the various conditions and effects of other-than-optimum recovery wind is depicted in *figure 17-2.*

EFFECTS OF WIND

SUMMARY

CONDITION	**EFFECT**				
	HIGH WOD	LOW WOD	XWIND	TURB	DOWNWIND
GLIDESLOPE	X		X	X	
LINEUP			X		
BOLTER RATE		X	X	X	X
POOR POWER RESPONSE		X			X
GREATER SINK RATE		X	X	X	X
ENGAGING SPEED		X			X
CROSSWIND LIMITS			X		
BASIC ANGLE	X				
BURBLE	X		X	X	X
PATTERN	X	X			X

Figure 17-2 Effects of Wind Summary Chart

CHAPTER 18

FIELD CARRIER LANDING PRACTICE (FCLP) AND CARRIER QUALIFICATIONS (CQ)

18.1 GENERAL

The purpose of FCLP is to provide pilots with landing practice using the Fresnel lens. Through repetition, pilots establish a feel as to proper corrections for approach deviations, and with experience through sensory cues, are able to accurately predict when a deviation will occur. Pilot performance during FCLP may not necessarily parallel performance at the ship, however individual trends as far as deviations/responses during FCLP are usually mirrored at the ship.

18.2 FCLP SCHEDULING

FCLP scheduling information is usually promulgated by the cognizant authority in an Air Operations Manual or instruction series for the respective air facility.

18.3 DAY CONSIDERATIONS

During VMC the strongest influence telling the pilot what his aircraft is doing is his peripheral senses; i.e., "seat of the pants feel." A pilot uses these senses to correlate aircraft performance with instrument positioning to reinforce acceptable corrections. FCLP should strengthen and refine these corrections. During daylight VMC the predominant sensory influence is the direct and peripheral sight picture as confirmed by sensed vertical and horizontal accelerations. By these senses and through repetitive approaches, a pilot is able to fly a centered ball all the way from start to touchdown making continuous corrections, yet without any perceived ball movements.

18.4 NIGHT CONSIDERATIONS

At night and with the absence of a horizon, sensed accelerations cannot be correlated through the peripheral sight picture, and pilots must rely on other inputs to confirm aircraft performance. Instrument scan is the primary reference, however direct sight picture is still very important, even if less accurate without the additional periphery for reference. The rectangular relationship of the landing area lights now acts to confirm relative height, distance and velocities. Relative ball movement correlated with perceived distances give coarse acceleration cues, usually resulting in somewhat coarser corrections. More reliance for sensory confirmation of aircraft performance shifts to the subtle areas of throttle/hand positions, length of time that a correction is in, rate of change in ball positions, and engine sound cues, coupled with perceived distance from touchdown.

18.5 FCLP GEOMETRY

The dynamics and geometry of FCLPs are similar to an actual carrier approach, but have some key differences. The differences need to be understood so that the compromises used will exploit desired aircraft performance characteristics and optimize pilot and LSO training.

18.6 GLIDESLOPE

18.6.1 Field/Ship Differences. The glideslope setting used for a FCLP will normally range from 2-3/4 to 3-1/4 degrees. At the ship, wind over the deck acts to decrease aircraft relative closure to the carrier deck, allowing more time for error detection and correction, and resulting in an actual glideslope that the aircraft flies being shallower than the set basic angle. This actual glideslope is approximately 3/4 degrees less than the basic angle and rarely exceeds 3.25 degrees. At the field, without the aid of that 30 knots wind over the deck, approach geometry is different. 3.25 degrees will simulate the actual ship's glidepath, however with less wind aircraft require lower power settings to stay on glideslope. At any given distance from the point of touchdown the aircraft will physically be 3/4 degrees lower during FCLP than at the ship. This equates to

39.8 feet at one half nautical mile and 79.6 feet at one nautical mile, a definitely perceivable difference.

1. When the majority of FCLP is conducted in the daytime where peripheral sight picture is a predominant influence, the higher glideslope settings result in a physically higher sight picture for both pilot and LSO. The higher angles allow for easier ball control as the aircraft nears touchdown due to steeper geometry and reduced float caused by ground effect and runway thermal updraft. You will sacrifice power response and engine sound cues, and may approach maximum sink rate stresses for the higher glideslope.

2. If most of the FCLP is night work where the other sensory influences predominate, the lower glideslope more closely simulates ship approach power settings response and engine sound cues, but results in a flatter glideslope which becomes increasingly difficult to control in close to at the ramp. LSO training may be sacrificed with this lower, flatter approach. Depending on the amount of horizon cues existing in the area of FCLP, the pilot may or may not realize the difference in glideslope settings. Vertical speed differences should not exceed 100 to 200 feet per minute.

3. Experienced pilots may sense the difference when using different glideslopes. Normally they will "feel" unusually high or low and may be reluctant to make power changes sufficient for early glideslope correction. Studies indicate LSO accuracy in determining glideslope may be as accurate as five feet at one half nautical mile once the LSO's eye is calibrated to the existing glideslope.

18.7 LSO OPERATIONS FOR FCLP AND CARQUAL

18.7.1 References. In order to safely and efficiently conduct an evolution of this magnitude, it is imperative that the following references are obtained, thoroughly reviewed and strictly adhered to:

- LSO NATOPS
- CV NATOPS
- Appropriate Aircraft NATOPS
- Type Commander Instructions

  Carrier Qualification

  Air Department Standard Operating Procedures

- Aircraft Launch and Recovery Manual
- Appropriate Airfield Operations Manual
- Appropriate Airwing/Squadron SOP

Procedures and policies governing CQ are more restrictive than during normal carrier operations and are promulgated in the joint COMNAVAIRLANT/COMNAVAIRPACINST 3740.2 series and the CNATRA CQ OPLAN.

18.8 PLANNING

18.8.1 Strategy. A working meeting with the CO, OPS O, MO, Training O and LSO will establish the overall concept of operations for the upcoming workup. In order to make a positive contribution, the LSO must be prepared to provide as a minimum the following information:

- State of pilot training
- Any unsafe tendencies of individual pilots
- State of assistant LSO assignment and training
- Latest technical developments of appropriate type aircraft, ship configurations, and equipment which concern the recovery of aircraft.
- Submit, via the operations officer, a list of anticipated FCLP requirements for each pilot in accordance with pilot currency criteria outlined in LSO NATOPS.

A productive meeting will provide the basis for establishing a schedule which satisfies

FCLP briefings, precarrier briefings, and FCLP flight operations while taking into account::

- Scheduling conflicts (i.e., Weapons Det, ACM Det, Inspections, Pre-sail Conf. etc.)
- "Sister" squadron coordination
- Aircraft availability
- Pilot availability
- Flexibility for the unexpected (i.e., WX)

NOTE

The airwing LSO shall be kept informed of the squadron's game plan.

18.8.2 Scheduling. An all-inclusive schedule will be drafted by the Operations Department with LSO assistance. It is recommended this schedule be formalized in a letter of instruction (LOI) format which encompasses the entire workup period. This schedule must consist of a comprehensive lecture series of FCLP and precarrier briefings as outlined in LSO NATOPS. Integration with NCLT training and required FCLP sorties is paramount. For simplicity, carrier qualification should be divided into two fundamental areas: field qualification and carrier qualification. Each area contains its own ground and flight syllabus, with appropriate procedures and responsibilities.

18.8.3 Lecture Syllabus. See Section III of LSO NATOPS for necessary pilot briefings prior to carrier operations.

FCLP

Lecture 1 - Fresnel lens, MOVLAS, LSO talkdown, ACLS equipment and procedures.

Lecture 2 - Local FCLP course rules, NALF/OLF course rules when applicable. General/specific FCLP procedures and techniques.

CARRIER QUALIFICATIONS

Lecture 3 - Carrier configuration, deck/launch procedures.

Lecture 4 - Case I/II launch & recovery.

Lecture 5 - Case III launch & recovery (AFCS, APCS, ILS, ACLS).

Lecture 6 - Special procedures i.e., EMCON, NORDO, other pertinent Airwing tacnotes.

Lecture 7 - Emergency procedures.

Lecture 8 - Operations/Air Department Brief (required within 10 days of CQ Ops by LSO NATOPS).

18.8.4 Simulator Syllabus

NCLT 1 - Case III Departure, CV-1, Marshal, ACLS Approach, Recovery.

NCLT 2 - CV-1 Arcing, ASR, Self-contained Approach, Downwind Procedures.

NCLT 3 - CV-3 Emergencies as recommended by LSO NATOPS.

18.8.5 Flight Syllabus *

FCLP 1 - Day

FCLP 2-7 - Night

FCLP 8 - Day (Emergency/MOVLAS period)

FCLP 9 - Night

FCLP 10 - Day/Night (Field Qual)

* The flight syllabus should reflect the requirements of each individual pilot. A ten-sortie syllabus as outlined above is recommended for an average fleet pilot on a six to twelve month turn-around cycle. The number of FCLP periods required to prepare a pilot for CV landings will vary with individual pilot skills, experience and currency in aircraft type. The senior squadron LSO is ultimately responsible for certifying to the CO that an individual is prepared for CV flight operations. Experience has shown a minimum of six and

maximum of ten approaches per sortie are considered optimum for FCLP training.

18.8.6 Schedule of Events.

First Week: Lectures 1-2. Day FCLP, Night FCLP

Second Week: Night FCLP

Third Week: Night FCLP, Lecture 3-5, Emergency/MOVLAS. NCLT 1-2.

Fourth Week: Lectures 6-8. NCLT 3. Day FCLP, Night FCLP, Field Qual. CQ.

Fifth Week: CQ continued, Debrief, Reports, Logs/Records.

18.9 GROUND TRAINING

18.9.1 Lectures. The responsibility of the LSO during ground training portions of the workup is two-fold: First, the development of a comprehensive lecture syllabus; and secondly, to present this material in such a fashion as to establish the highest probability for retention.

1. Preparation

- Know your audience and tailor lecture accordingly
- Limit lecture to a single topic
- Determine learning media (75% of learning is visual)
- Develop a topic in a logical sequence
- Attention getter draws audiences to speaker
- Present the big picture
- Body will contain the bulk of material
- Conclusion should be time to drive home the point and answer questions

2. Presentation

- Rehearse

- Prep classroom by removal of distractors
- Your personal appearance is representative of your professionalism.

- Utilize good gesture/lecturing techniques

  - Move around (but not too much)

  - Speak up and sound confident

  - Make eye contact

  - Use questions (if applicable)

  - Practice audience control

- Don't apologize before you start

18.9.2 Simulators. Carrier landing simulation shall be used to the maximum extent practicable in preparation for shipboard operations. The LSO shall develop a simulator syllabus to supplement FCLP training and reinforce precarrier briefing material. Each pilot should complete the simulator syllabus prior to carrier operations.

NOTE

The LSO shall conduct a formal briefing with all pilots prior to simulator flights covering the procedures and training objectives to be accomplished.

18.10 FCLP

18.10.1 Requirements

1. **FCLP Briefings.** Subjects outlined in LSO NATOPS Part III shall be covered by the LSO prior to and, as necessary, during FCLP training.

2. **Preflight Briefings.** Pilots shall be briefed prior to each FCLP period in accordance with NATOPS flight manuals and briefing criteria outlined in LSO NATOPS Part III.

3. **Conduct of FCLP** (LSO NATOPS Part III)

- Ensure LSO personnel requirements are fulfilled

- Conduct equipment checks prior to FCLP operations

- Monitor all aircraft in the pattern to ensure proper interval and adherence to briefed FCLP pattern procedures/course rules.

- Evaluate each pilot's demonstrated proficiency in the specific areas outlined in LSO NATOPS.

4. **Debrief**

- Establish time and location during brief

- Location should be non-distracting environment (i.e., no topless bar debriefs)

- Techniques (See Chapter 19)

5. **Performance Records.** Fleet squadrons shall maintain records of all squadron pilot FCLP landings from the beginning of shore-based operations until the end of the next extended deployment.

6. **Pilot Certification.** When a pilot has demonstrated his ability to operate with appropriate configurations and simulated emergencies an oral or written recommendation shall be submitted by the senior LSO to the pilot's commanding officer certifying pilot day/night FCLP qualification.

NOTE

The senior Wing LSO will recommend revocation of a certification at any time a pilot's standard of performance is less than satisfactory.

18.10.2 Considerations

1. Prioritize pilots against number of "up" aircraft.
2. Avoid working mixed patterns.
3. Brief IFR back up plan.

18.11 CARRIER QUALIFICATION

18.11.1 Planning

1. **Pre-sail Conference.** Approximately one to two weeks prior to sail date the designated Carqual ship's personnel will meet the TYCOM, CVW, squadron and TRACOM representatives to brief the concept of operations and specific procedures. Upon review of initial carrier landing qualification and refresher criteria, the squadron Carqual/ refresher requirements are confirmed at this time. For fleet carqual periods, the TYCOM LSO will normally brief LSOs during this meeting. This responsibility is usually relegated to the Airwing LSO for airwing REFTRA periods.

2. **Operations and Air Department Briefings.** Pertinent areas outlined by LSO NATOPS shall be briefed by cognizant Operations and Air Department personnel within 10 days of initial carrier qualification/ refresher carrier landings. Squadron LSOs should coordinate with the ship/airwing.

3. **Review of applicable Recovery Bulletins**

4. **Other Considerations**

- Determination of "walk aboards" vs. "fly aboards" must be based on pilot performance and currency vice personal desire.

- Squadron OINCs, Duty Officers, Pri-fly/ CATCC Representatives should be thoroughly briefed in regard to matters having impact on the Carqual evolution from the LSO perspective.

- Assignment of LSOs to conduct FCLPs may be required in the event the Carqual period is delayed for scheduling or for an unexpected occurrence such as inclement weather.

- See section III of LSO NATOPS for necessary pilot briefings prior to carrier operations. You may want to provide maintenance with aircraft requirements for shipboard operations:

  - Tires carrier pressurized
  - IFR probe and AOA probe inspected
  - Hook inspection and check for high time
  - Mode II/ACLS address and Mode 4 IFF codes set
  - UHFs channelized
  - Check navigation and approach lights, beacon augmenter or radar reflector, ARA-63, and ASW-25

18.11.2 Carqual Operations

1. **LSO responsibilities.** Duties and associated responsibilities of the LSO are depicted in the below listed directives. It is incumbent upon each LSO to be thoroughly familiar with his duties and responsibilities.

- LSO NATOPS Part III
- CV NATOPS Chapter 5
- Air Department SOP (CNAL/CNAP Inst. 3100.4) pages 1-2, 2-7 and Chapter 6
- Aircraft Launch and Recovery Manual (CNAL Inst 13800.3/CNAP Inst. 13800.9) Section IV

2. **LSO - Air Department Interaction.** The onus is placed upon the embarking LSO to introduce himself and assistant to the Air Boss and Air Operations Officer. Developing a strong rapport should improve communication, thereby enhancing the Carqual evolution.

18.11.3 Post CQ Period

1. **Debrief.** In addition to the recurring debriefs during the Carqual evolution the LSO will give each pilot a thorough debrief after assessing overall performance and conducting trend analysis.

2. **LSO Certification of Pilot Performance.** The cognizant LSO shall report orally and in writing when individual pilots have completed day/night carrier qualification. The originals of such reports shall be delivered to the appropriate Squadron Commanding Officer or Wing Commander, who will certify the pilot is day/night carrier qualified. Copies shall be provided for pilot training jackets and LSO files.

NOTE

> The cognizant senior LSO may recommend revocation of a qualification any time a pilot's standard of performance is less than satisfactory.

3. **Pilot Performance Records.** The LSO shall keep a smooth carrier landing trend analysis for all pilots making carrier landings in aircraft for which his command is reporting custodian using OPNAV Form 3760/71 or by using the APARTS system, if available.

4. **Other Considerations.** Subsequent to carqual, the LSO may be required to submit an input for consolidation with the embarked O-IN-C's post CQ report.

CHAPTER 19

DEBRIEFING

19.1 GENERAL

Of all the functions the LSO performs debriefing is one of the most important and is one function that separates good LSOs from bad. Almost anyone can be trained to observe and grade a pass, but not all LSOs will ever learn how to most effectively debrief a pilot.

To be an effective debriefer the LSO must understand personalities (including his own) and psychology, be forceful yet tactful, know his business, not compromise his standards, retain his credibility and above all remain professional.

19.2 PURPOSE

The purpose of debrief is to inform and educate the pilot. The tone of the debrief should always be positive (i.e., don't just tell a pilot what he did wrong, but attempt to inform what he could have done better and/or what he did well or correctly. Remember, the grade is not the important element here, but rather quality of error detection and correction. The pilot should learn something from every pass he flies but he won't if he's not debriefed properly.

19.3 PRE-DEBRIEF

Every successful debrief is preceded by an unbiased quality assurance check. Prior to starting the debrief, the LSOs should review each pass, concentrating on accuracy and coherency, and noting any which may be potentially difficult to debrief. Not only does this ensure the pass is fresh in the LSO's mind, it ensures valid learning points are noted.

19.4 CONDUCT

The tone of the debrief is primarily set by the LSO. If the LSO enters the ready room and exhibits a positive, professional attitude the debrief will most likely transpire positively. The LSO's approach should be forceful but not demeaning. Eye contact is extremely important. The image presented should be one of aviator to fellow aviator, not of instructor to student.

Frivolity and levity are rarely useful tools, although they can be used to "break the ice" or conclude the debrief on a cheerful note. Foul or abusive language and harassment are never appropriate.

Basic rules for a successful and productive debrief.

1. Be professional

2. Be firm and positive.

3. Make eye contact.

4. Don't just read from the book.

5. Know your business.

Other debriefing gouge to consider:

M Never start the debrief with the word "OK"

M Avoid starting the debrief with the grade

M Never argue with the pilot

M Never give the passbook to a pilot; debrief from it

M Avoid debriefing an NFO separately (particularly prior to the pilot)

M Spend extra time debriefing nuggets, especially with techniques to improve their performance.

CHAPTER 20

WAVING CONCEPTS

20.1 GENERAL

VOICE CALLS

1. As a general voice call strategy, informative and advisory calls are used early in an approach and imperative calls are used late in the approach. A shift to more imperative voice calls may be required for a disoriented pilot or for demanding environmental/weather conditions.

2. A calm and confident sounding "Roger Ball" (or "Paddles Contact") is critical to pilot confidence in the LSO. An excitable or unconfident sounding call may have a negative effect on subsequent pilot responsiveness.

3. Try to wave such that the pilot makes his own corrections. When his performance or recovery conditions start deteriorating, you must increase your involvement in the pass.

4. LSO must be alert for a settle on lineup corrections. A "power" call prior to the lineup call should be considered when aircraft is in close.

5. At least one LSO must **always** be monitoring the radio during a recovery. As controlling or B/U LSO, avoid redirecting your attention (such as to the LSO Log Book or phone calls) when your eyes should be on approaching aircraft, deck status, etc.

SCAN

1. LSO scan breakdown (GS, LU, AOA cues) can lead to drastic deviation in one dimension. A common LSO (and pilot) mistake is excess attention to GS at the expense of the LU. Thus, the backup LSO must also be actively involved in the pass and alert to breakdown of the controlling LSO=s scan.

2. LSOs can become perceptually "deceived" by a smooth approach with a minor deviation (such as little high). This can negatively affect critical perceptions in close and can also hurt LSO credibility during debrief. This deception can also be brought on by a series of smooth approaches with some deviation. Over a period of time, pilots will try to fly the type of approach that they think the LSO wants to see for an OK grade.

EQUIPMENT

1. Do not let the lens be turned on until you have the capability to communicate and to use the pickle.

2. LSO (or backup, or other team member) must always check lens setting before each pass. Proper arresting gear weight settings must also be verified.

3. Do not accept an aircraft without an approach light or with a flashing approach light. If possible, ask pilot to check gear or hook (as appropriate) well prior to ball call. LSO NATOPS provides specific guidance.

4. Do not secure from the LSO platform with the lens still on.

WAVE-OFF

1. LSOs have dual waving responsibilities, a safe **and** expeditious recovery). The safety aspect must **never** be compromised.

2. The wave-off call must be given firmly but calmly. An over-excited call may lead to excessive pitch response from the pilot and an inflight engagement.

3. Always use waveoff call and pickle simultaneously when waveoff is required.

4. Inside the normal waveoff point, use waveoff any time deck goes foul and any time 100% power is needed for aircraft to clear ramp.

5. After 2 or 3 power and/or attitude calls without sufficient pilot response, use the waveoff.

20.2 PILOT CONSIDERATIONS

EXPERIENCE

1. LSO should consider a very inexperienced pilot as especially unpredictable, however, LSO should not "lower his guard" for highly skilled or experienced pilots. They will occasionally make critical, unpredictable errors requiring waveoff.

2. Low proficiency in pilots can be evidenced by poor starts.

3. LSO should consider moving waveoff point out slightly for a pilot known to be unproficient.

4. Early wires and bolters over a period of time by the same pilot is indicative of "deck-spotting".

PAST PERFORMANCE

1. The quality level of a pilot's past performance (FCLP or CV ops) is no guarantee of the same on any given approach.

2. LSO should never assume that a pilot can salvage an approach without LSO help.

3. LSO should never assume that a pilot will make the proper correction for a given deviation.

4. The pilot who experiences more than 2 passes (possibly excluding foul deck waveoffs) to get aboard has a higher probability of making radical corrections in-close to in-the-wires. Ease the anxiety of pilots who have experienced multiple passes on a given recovery by talking to them and debriefing any trend. Increase your involvement in subsequent passes to guarantee a safe recovery.

5. For CQ-type "endurexes", the last pass has a good probability of exhibiting some type of "get-aboard-itis".

UNRESPONSIVENESS

1. If LSO notes slow pilot responsiveness consider moving waveoff window out further from ship.

2. LSO should never assume that the pilot will make the correct response to an LSO call in close. Be prepared to follow up the call with waveoff.

3. Waveoff should be used for an unresponsive pilot.

DISTRACTIONS/VERTIGO

1. Any malfunction which causes a change in the normal pilot habit patterns can degrade the visual approach (i.e., no TACAN, no needles, no gyro).

2. For a disoriented pilot (i.e., vertigo) or one suffering from fatigue, the LSO may have to "climb into the cockpit" (i.e., LSO talkdown) to effect a safe recovery (however, do not stay there if you do not have to).

3. Waveoff point should be moved out for a disoriented pilot.

20.3 APPROACH PROFILE

STARTS

1. Poor trends leading to the start and at the start are good indicators that the pass is going to be a problem due to pilot disorientation or poor pilot scan.

2. A major glideslope deviation at the start to in-the-middle is difficult for the pilot to salvage. Extra LSO assistance is needed to help pilot get aboard.

3. During day recoveries, beware of pilot tendency to try and salvage an extremely poor start (i.e., OSX, NESA, HFX, HFX, etc.). If not stable approaching in-close position, use waveoff.

4. A poor start frequently leads to overcontrol tendencies in the remainder of the pass.

DEVIATIONS

1. For significant multiple deviations in close, a waveoff should be used by the LSO. As a rule of thumb, if 2 major deviations (from among GS, LU, AOA or power) are AFU approaching the waveoff point, use waveoff. This is especially critical during CQ.

2. For unsettled dynamics (speed, power, wing position, flight vector, pitch) in close, LSO should consider giving a waveoff.

3. Be prepared for sink rate increases during late lineup corrections.

4. LSO should not accept a low trend on an approach.

5. LSO should not accept a high-all-the-way trend on approach.

BE PREPARED

1. More ramp strikes occur when a pilot is correcting for a high deviation in close than for a low deviation.

2. High at the ramp with less than optimum rate of descent can lead to a dangerously long bolter. Do not hesitate to use waveoff.

3. High at the ramp with excessive rate of descent can easily result in a hard landing.

4. During CQ, pilot scan is usually slow, therefore, be extremely cautious of multiple deviations in-the-middle to in-close.

5. Be alert for the "moth effect" (drift left in close or at the ramp) due to pilot fixation on the meatball at the expense of lineup.

20.4 AIRCRAFT CHARACTERISTICS

ENGINES/APC

1. If calls are necessary for aircraft with slow engine response (S-3, F-14), they must be given well prior to glideslope interception when correction is being made for a high deviation.

2. For aircraft with excellent engine response (EA-6B, E-2C), be alert for pilot over control of power. This also includes excessive power reductions following too much power.

3. For aircraft which have difficult APC disengagement, waveoff point should be moved out slightly.

4. APC should not be used in high wind conditions (greater than approximately 35 knots).

5. If one attitude call does not get sufficient pilot response, switch to a power call (or waveoff, if needed).

6. For T-45, slow spool up time (turbofan engine), do let it stay back on the power.

7. For T-45, tendency is to be over powered, especially in close. Difficult to correct.

LINE-UP

1. Lineup control for "slow movers" (S-3, E-2, T-45) is more critical in shifting wind conditions than for "fast movers".

2. For EA-6B, beware of settle on lineup correction, especially when aircraft is LOSLOIC.

3. Large wing-span aircraft (i.e., E-2, S-3, F-14, etc.) must be on lineup and have little or no drift by the in close position. EA-6B aircraft must be wings level prior to touchdown to preclude possible damage to wingtip speedbrakes with large late lineup correction.

RATE OF DESCENT

1. For F-14, HFIM-IC trend is potentially disastrous due to DECS potential.

2. For F-14, do not allow HCDIC trend. Excess sink rate is difficult to stop with power.

3. For F-14, in a HNDIC situation with APC, excessive sink rate will result and is hard to stop unless a very timely call is given.

4. F-14B and F-14A w/ MOD DLC have significantly increased DLC authority over F-14A. Beware of excessive sink rates developing from power reduction in conjunction with DLC activation.

WIND OVER DECK

1. For F/A-18 and F-14, due to normally high approach speed, LSO must pay close attention to closure under light WOD conditions.

2. For E-2/S-3, aircraft glideslope control through the "burble" is difficult under high WOD conditions. Starboard winds accentuate the "burble" and make glideslope control increasingly difficult for most aircraft.

NOSE MOVEMENT/ATTITUDE

1. For F/A-18, do not allow significant nose movement and/or power reduction, especially for HIC deviation.

2. For EA-6B, glideslope control is very sensitive to nose movement and can also lead to a decel.

3. For S-3, beware of a drop nose in conjunction with DLC activation in close. Excessive sink rate will result.

4. For T-45, power still controls glideslope B but use of nose to influence aircraft is valid/taught technique.

20.5 MALFUNCTIONS

1. Whenever time permits, obtain briefing on aircraft malfunction. Try to avoid relying on memory. Determine pilot workload for the malfunction and increase involvement in the pass accordingly.

2. Be aware of possible configuration and/or speed differences for an aircraft with a malfunction. Verify approach speed and utilize actual aircraft weight for arresting gear setting if minimum recovery wind is a problem.

3. For aircraft with configuration (i.e., FLAP/SLAT) problems or loss of an engine, consult ARBs to determine if non-standard hook-to-eye input needs to be made to CLASS system.

4. With less than optimum lighting configuration, LSO range discrimination is degraded, this causing difficulty in determining a safe waveoff point. Be alert for effects of autokinesis while controlling aircraft with reduced lighting.

5. For an aircraft with only a single light visible, consider having the NFO use his flashlight as an extra reference. Also consider having CATCC or B/U LSO provide range calls.

6. For a NORDO aircraft, move waveoff window out. Always use voice calls in addition to light signals.

7. Remain alert for malfunction during ACLS Mode I approach. Smooth trends early in approach are no assurance of successful termination.

8. For single engine approach, do not accept a poor start or a high deviation after the "in the middle" position.

9. F-14B single engine secondary mode (SESM) CV landings are severely restricted due to potential significant loss of available thrust.

10. Lineup control is more difficult for non-centerline thrust aircraft operating single engine, such as E-2, F-14, S-3 due to yaw.

11. For F-14, without DLC engaged, aircraft is further back on power than normal, thus resulting in reduced engine responsiveness.

12. For S-3, without DLC, nose pitch is very sensitive to power changes.

20.6 ENVIRONMENT

REDUCED VISIBILITY

1. For reduced visibility situation with a late breakout (inside 3/4 mile), the LSO must track aircraft positioning and trends with whatever means are available (SPN42, LSO HUD/CCA calls, etc.) so that there are no surprises. The LSO must be prepared to give timely aid to the pilot or make a timely waveoff decision.

2. Under reduced visibility conditions, the pilot has more difficulty seeing visual landing aids than LSO does seeing aircraft. Be prepared to provide extra assistance.

3. LSO talkdown may be required when pilot visibility is reduced by glare, rain, canopy fog, etc. If pilot can not see by 1/4 - 1/2 mile, he should waveoff or be waved off.

WOD

1. With a high WOD situation (35 knots or more) aircraft aerodynamics can rapidly deteriorate to a settle in-close with only slight power or aircraft attitude changes. Do not use APC in this situation.

2. With a low WOD situation (less than 25 knots), the high closure rate does not allow much margin for salvaging a come down or settle in-close, therefore, move the waveoff window out.

3. Starboard crosswind causes increased sink rates at the ramp.

4. Crosswind conditions can cause rapid drift rates in close and at-the-ramp.

5. During crosswind conditions be prepared for increased sink rates with late lineup corrections.

6. LSO (or B/U) must continually check closure speed to ensure adherence to max engaging speeds, especially under low WOD conditions.

7. LSO should inform pilot of abnormal WOD conditions.

8. For WOD greater than 40 knots, a 4.0 degree basic angle should be used. When basic angle is changed, CATCC must be informed.

NO HORIZON/PITCHING DECK

1. When there is no horizon and deck is moving, have plane guard destroyer or helo positioned aft of the ship near final bearing to aid glideslope reference.

2. When deck is moving, move waveoff window out.

3. With pitching deck conditions, be very hesitant to accept a high deviation in close.

4. With no visible horizon use CLASS ramp motion indicator to help predict deck pitch cycle; however, remember that there is some lag in the indication.

5. With no horizon reference available, use other means (HUD, SPN-42) to insure proper eyeball calibration.

20.7 LSO RESPONSIBILITIES

MOVLAS

1. Ensure pilots are informed when MOVLAS is in use.

2. MOVLAS must be moved enough to enable pilot to discern ball movement.

3. More LSO calls than usual should be made when MOVLAS is in use with pitching deck conditions.

4. The LSO must avoid the "high eye" tendency when using MOVLAS.

5. When working MOVLAS, do not delay the waveoff decision. Remember that you are busier than usual.

6. The B/U LSO should never assume that the controlling LSO will keep aircraft off the ramp or that the controlling LSO has a handle on a lineup deviation. Be prepared (as B/U LSO) to give waveoff. Additionally, a B/U LSO who is junior to the controlling LSO shares as much responsibility in the safe recovery of aircraft and should not assume that the more senior controlling LSO by virtue of his experience, will keep aircraft within acceptable parameters.

7. With a starboard side MOVLAS, expect some breakdown in pilot scan, especially in side-by-side seated aircraft (EA-6B, E-2).

<u>LINE-UP</u>

1. As controlling LSO, do not become too dependent on aircraft control inputs from B/U LSO.

2. The PLAT is one primary lineup reference for the LSO (especially the B/U LSO). LSOs, however, must be aware of two common problems with using the PLAT while waving:

a. PLAT fixation for aircraft control - LSO loses all cues for glideslope control (PLAT glideslope crosshair is not suitable for this) and the entire approach "picture".

b. "Snapshot" glance at PLAT - only reveals aircraft's instantaneous lineup deviation. LSO may not perceive a lineup drift or trend with a single quick glance at the PLAT.

<u>GENERAL</u>

1. Backup LSO should always visually check the landing area as approaching aircraft cross the wake to verify proper foul deck waveoff point. After the ball call, other LSOs on the platform may assist this effort using the voice calls "aircraft", "men", or simply "foul deck" to affirm the 100 or 10 foot minimum altitude.

2. LSO should maintain control of a "Paddles contact" approach to touchdown. Train CATCC controllers to continue control unless the term "Paddles Contact" is used. This allows the LSO to use a single informative or advisory voice call to assist a pilot without assuming "paddles contact" control. "Paddles Contact" should only be used as a last resort, i.e., CATTC cannot get the aircraft to an acceptable start.

3. A fatigued or medically grounded LSO should not be waving.

20.8 SHIP CONDITIONS

1. With late wire(s) missing and a hook touchdown point change, do not forget that hook-to-ramp clearance has been reduced.

<u>BARRICADE</u>

1. For barricade engagement, give "cut" call prior to engagement, but only after ramp is made.

2. For barricade recovery, remember that pilot's view of meatball will be lost temporarily in-close.

3. For barricade recovery, waveoff point must be moved out significantly.

4. For a barricade recovery, commanded on-glideslope hook-to-ramp clearance should never be less than 8 feet.

5. For barricade recovery, remember that hook-to-ramp clearance is reduced (and is different for each aircraft type) and that basic angle is 4.0 degrees.

6. For barricade recovery, remember that hook touchdown point is different for each aircraft type. Line-up is critical due to no centering capability of barricade engine ($\pm$8 feet for jet aircraft; $\pm$2.5 feet for E-2/C-2).

DECK MOTION/MISTRIM

1. Avoid allowing a drift particularly when ship is listing.

2. With a ramp out-of-trim condition, touchdown angle is changed. Try to minimize excess sink rate landings for ramp down condition. A higher incidence of hook-skip bolters is possible with ramp out-of-trim.

3. When deck is moving, LSO must make more voice calls that usual.

4. As a rule of thumb, if 50% or more of the passes are indicative that pilots are "chasing the ball", MOVLAS should be rigged. If stabilization appears good, stick with lens.

5. When aircraft is lined up left in close, it is easy for the controlling LSO to lose track of deck motion cycle.

6. When deck is moving, be alert for "dutch-roll" which affects lineup as well as glideslope.

7. Use CLASS indicator to help detect out-of-trim condition for ship and its effect on hook-to-ramp clearance.

20.9 OPERATIONAL SITUATION

1. Do not let low fuel state situation or any other boarding pressure cause you to lessen the safety margin for an approach.

2. For a situation requiring increased need for a trap, give extra aid to pilot earlier than usual in an approach. Work to get aircraft in a "workable" position in close (i.e., more advisory calls early).

3. Do not use calls that can be misinterpreted by the pilot as "go for it". Even the perception of a "Buffalo" call can illicit unacceptable corrections.

4. When supervisory personnel demonstrate confusion or incompetence, LSO must know the rules (i.e., max. engaging speeds, ramp "tap" to divert or barricade, crosswind limits, etc.) and be prepared to assert himself ("hang it out") to ensure correct action is taken.

5. When CATCC "loses the bubble" on aircraft control, LSO must be prepared to safely salvage the situation.

6. Under ZIPLIP/EMCON conditions, safety is still paramount, therefore, do not hesitate to use voice calls as needed.

7. Do not allow use of platform calls like "wire coming back" and "good chance." They could influence the controlling LSO to press the waveoff point in a foul deck situation. Do not attempt to predict a clear deck.

8. When directed to wave under obviously unsatisfactory recovery conditions (i.e., insufficient WOD, excessive crosswind, etc,) the pickle can be a very effective tool for aborting the recovery process.

9. Never press the waveoff decision point or compromise hook-to-ramp clearance no matter what real or perceived boarding rate pressure exists.

10. Move the waveoff point out when there are men on deck or aircraft in landing area. A foul deck waveoff shall be initiated such that normal aircraft waveoff response will allow the aircraft to pass no closer than 10 feet to the landing area. If aircraft, personnel or equipment are in the landing area, the waveoff shall prevent the aircraft from passing within 100 feet from the highest obstacle in the landing area.

11. A change in targeted hook touchdown point should be considered for missing wires.

12. CATCC voice calls may indicate that the SPN-42 glideslope is improperly calibrated. Inform them if such is the case.

13. If closure speed readout is not available on the platform, consider asking for speed calls from Air Boss or CATCC.

14. For normal recovery ops, commanded on-glideslope hook-to-ramp clearance should never be less than 10 feet.

CHAPTER 21

AIRCRAFT DATA

21.1 GENERAL

In order to successfully control aircraft in the carrier landing environment and manage recoveries through intelligent decision making, the LSO must have a thorough knowledge of aircraft characteristics. Aircraft design forces certain "givens" on the pilot and LSO. Performance characteristics dictate the degree of difficulty in maintaining desired parameters. The limitations imposed by degraded systems or emergency situations make the pilot's and LSO's job more difficult by denying normal capabilities or imposing restrictions. These restrictions may include landing in unusual configurations that will demand a higher than normal workload. The following tables delineate some general/specific design and performance characteristics and waving considerations for the various aircraft currently in operational use. This information is intended to provide LSOs with a very basic understanding of the similarities and differences between these aircraft. The primary source of an LSO's understanding of these characteristics and considerations will be through hands-on OJT on the LSO platform.

21.2 E-2C, E-2C PLUS

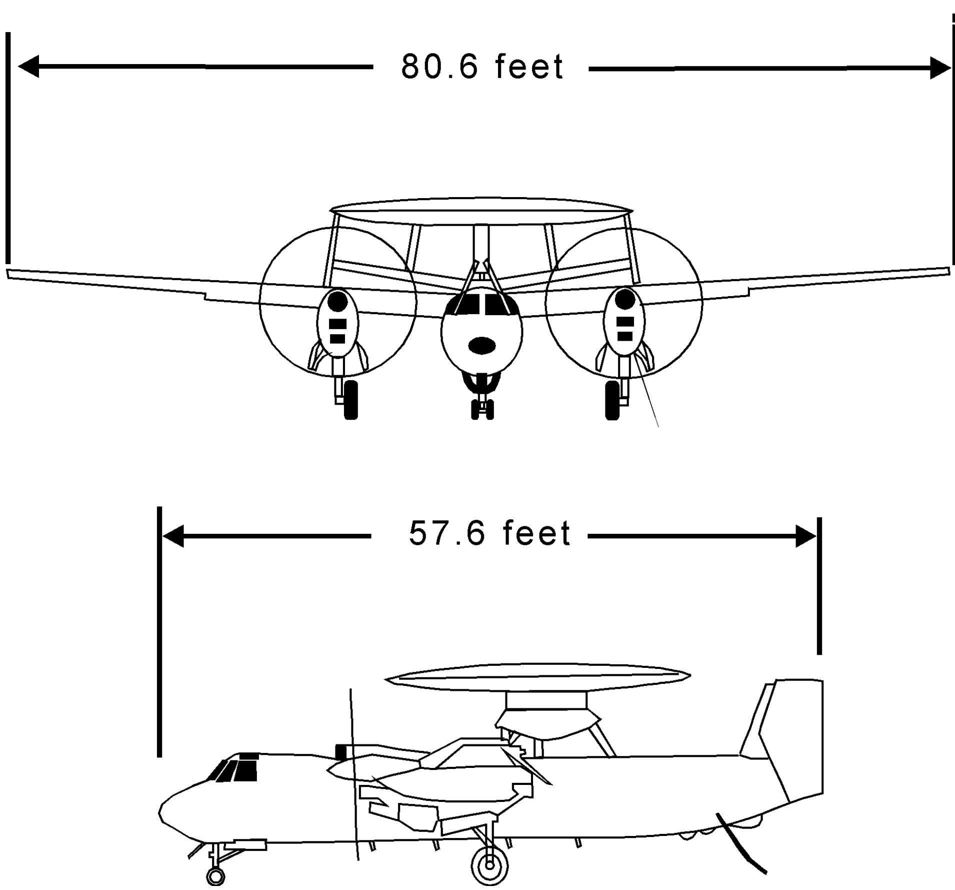


Figure 21-1 E-2C, E-2C PLUS

E-2C DESIGN

DIMENSIONS	Wing span - 80.6 feet Fuselage - 57.6 feet, H/E - 15.0 feet Basic weight - 40,100 pounds Landing configuration: - Full flaps (2/3 flaps for high WOD) - Approach light on - gear down and locked - Flashing approach light - tow link down
EXTERNAL LIGHTING	Approach light Wing tip lights Red aft "attitude" light Red strobe lights top of vertical stabilizer and below fuselage
APPROACH MODES/AIDS	No APCS No ICLS ACLS Modes II and III
FUEL	Max trap fuel - 4,900 pounds (4,100 - 4,300 with SATCOM) Day/VFR - 250 pounds per pass Night/IFR - 500 pounds per pass
RESTRICTIONS	Max trap weight - 45,500 pounds

E-2C PERFORMANCE

GLIDESLOPE	Turboprop engines, excellent response Nose, power and rudder coordination Gust responsive
LINEUP	Critical due to wing span Gust responsive Directional instability Aft "attitude" light for yaw and pitch cue Balanced flight
AOA/SPEED	Approximate max trap speed - 104 knots Day - vert stab 1/3 above wing - slight gap between flaps and hor stab Night - approach light below wing light
WAVEOFF	Excellent response Slow approach speed Pitch attitude on waveoff
TENDENCIES	Drop nose Right to left drift
MISHAP TRENDS	Off-center landings In-flight engagements

E-2C MALFUNCTIONS/EMERGENCIES

1/3 FLAPS	15 knots faster Slow approach light H/E increases to 17.4 feet Check H/E, WOD Altitude loss on waveoff increases by 25%
NO FLAPS	Divert if possible 29 knots faster Slow approach light H/E increases to 18.7 feet Check H/E, WOD Altitude loss on waveoff
PITCH FEEL FAILURE	May require 130 pound forward stick force
TOW LINK DOWN	Strip 3 and 4 wires
SINGLE ENGINE	Divert preferred 2/3 flaps Don't allow deceleration Waveoff earlier Bolter - power added smoothly Lineup critical due to directional instability
BARRICADE	Special barricade required Nose wheel on deck to ensure props pass beneath upper loading strap Max gross weight - 45,000 pounds Max engaging speed - 86 knots Off-center limits ∀2.5 feet Check HTDP, WOD

E-2C PLUS DESIGN

(Difference data is highlighted)

DIMENSIONS	Wing span - 80.6 feet Fuselage - 57.6 feet, H/E - 15.0 feet Basic weight - 40,300 pounds Landing configuration: - 2/3 (20°) flaps - Approach light on - gear down and locked - Flashing approach light - tow link down
EXTERNAL LIGHTING	Approach light Wing tip lights Green aft "attitude" light Red strobe lights top of vertical stabilizer and below fuselage
APPROACH MODES/AIDS	ICLS ACLS Modes II and III
FUEL	Max trap fuel - 3,600 pounds Day/VFR - 200 pounds per pass Night/IFR - 400 pounds per pass
RESTRICTIONS	Max trap weight - 46,500 pounds

E-2C PLUS PERFORMANCE

GLIDESLOPE	Turboprop engines, excellent response Slightly less responsive than E-2C Nose, power and rudder coordination Gust responsive
LINEUP	Critical due to wing span Gust responsive Directional instability Aft "attitude" light for yaw and pitch cue Balanced flight
AOA/SPEED	Approximate max trap speed - 115 knots Day - vertical stabilizer 1/3 above wing Night - approach light slightly below wing light
WAVEOFF	Excellent response; slightly less responsive than E-2C Slow approach speed Pitch attitude on waveoff
TENDENCIES	Drop nose Right to left drift
MISHAP TRENDS	Off-center landings In-flight engagements

E-2C PLUS MALFUNCTIONS/EMERGENCIES

1/3 FLAPS	4 knots faster Slow approach light (22 vice 20 units AOA) H/E increases to 17.4 feet Significant altitude loss on waveoff; move waveoff window out
NO FLAPS	Divert if possible 10 knots faster Slow approach light (24 vice 20 units AOA) H/E increases to 18.7 feet Check H/E, WOD Significant altitude loss on waveoff; move waveoff window out
PITCH FEEL FAILURE	May require 130 pound forward stick force
TOW LINK DOWN	Strip 3 and 4 wires
SINGLE ENGINE	Divert preferred 2/3 flaps Don't allow deceleration Waveoff earlier Bolter - power added smoothly Lineup critical due to directional instability
BARRICADE	Special barricade required Nose wheel on deck to ensure props pass beneath upper loading strap Max gross weight - 46,500 pounds Max engaging speed - 86 knots Off-center limits ∀2.5 feet Check HTDP, WOD

21.3 C-2A

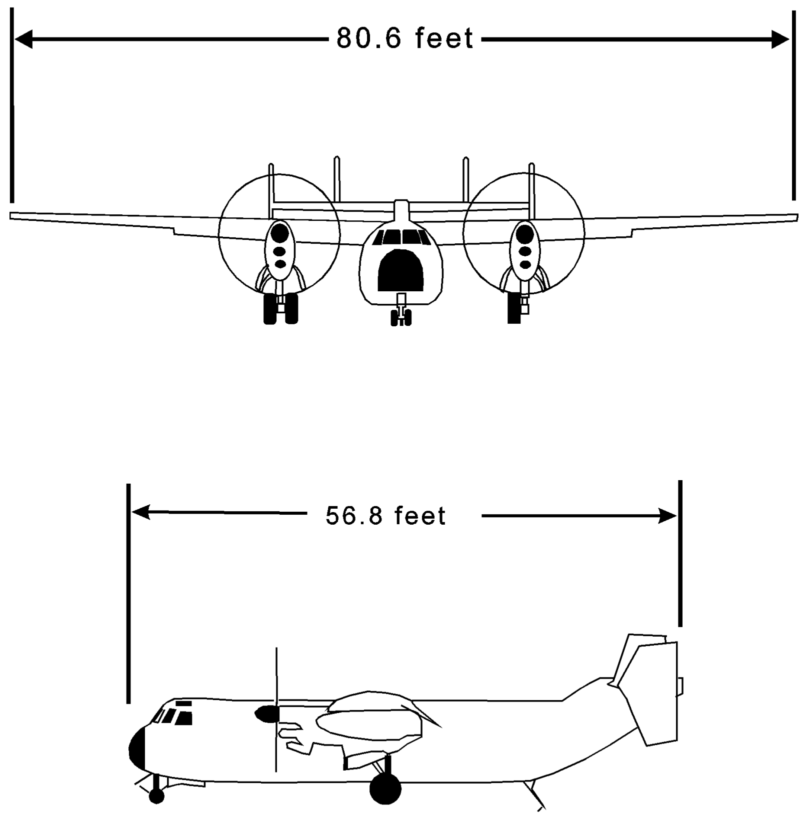


Figure 21-2 C-2A

C-2A DESIGN

DIMENSIONS	Wing span - 80.6 feet Fuselage - 56.8 feet, H/E - 15.0 feet Basic weight - 38,000 pounds Max catapult takeoff weight - 57,500 pounds Landing configuration: - 2/3 flaps (20°) - recommended; 25 knots minimum RHW - Full flaps (30°) - If operational necessity dictates, 30° flap approaches are acceptable for 46,000 to 49,000 pounds.) - Approach light on - gear down
EXTERNAL LIGHTING	Approach light Red/green position Wing tip lights Lower and upper anti-collision/strobe light Amber aft attitude light
APPROACH MODES/AIDS	ICLS ACLS Modes II and III only
FUEL	Max trap fuel - 11,000 pounds (no cargo) Day/VFR - 300 pounds per pass Night/IFR - 500 pounds per pass
RESTRICTIONS	Max trap weight - 49,000 pounds No cargo or passengers for CQ 30° flaps (operational necessity - 46,000 to 49,000 pounds)

	Approach flying qualities require 25 knots min RHW with 2/3 flaps

C-2A PERFORMANCE

GLIDESLOPE	Turboprop engines, excellent response Nose, power and rudder coordination Gust responsive
LINEUP	Critical due to wing span Gust responsive Directional instability Aft "attitude" light for yaw and pitch cue
AOA/SPEED	20° flaps/20 units AOA - max trap speed 109 knots (@ 49K) Day - 1/3 of center vertical stabilizers visible above wings Night - approach light slightly below wing tip lights
WAVEOFF	Excellent response Slow approach speed Pitch up tendency on waveoff Poor at > 10° flaps on single engine
TENDENCIES	Drop nose Chase lineup Floats/glides (BAR)
MISHAP TRENDS	Off-center landings In-flight engagements

C-2A MALFUNCTIONS/EMERGENCIES

1/3 FLAPS (10°)	9 knots faster than 20° flaps Slow approach light H/E increases to 16 feet Altitude loss on waveoff
NO FLAPS	Divert if possible 17 knots faster than 20° flaps Slow approach light H/E increases to 17.0 feet Check WOD Altitude loss on waveoff, move waveoff window out
PITCH FEEL FAILURE	May require 130 pound forward stick force
TOW LINK DOWN	Strip 3 and 4 wires
SINGLE ENGINE	Divert preferred 2/3 flaps, 20 units AOA Waveoff earlier Bolter/waveoff - add power smoothly
BARRICADE	Special barricade required Max gross weight - 47,500 pounds Max engaging speed - 86 knots Off-center limits ∀2.5 feet Check HTDP, WOD min 20 kts

21.4 S-3 A/B

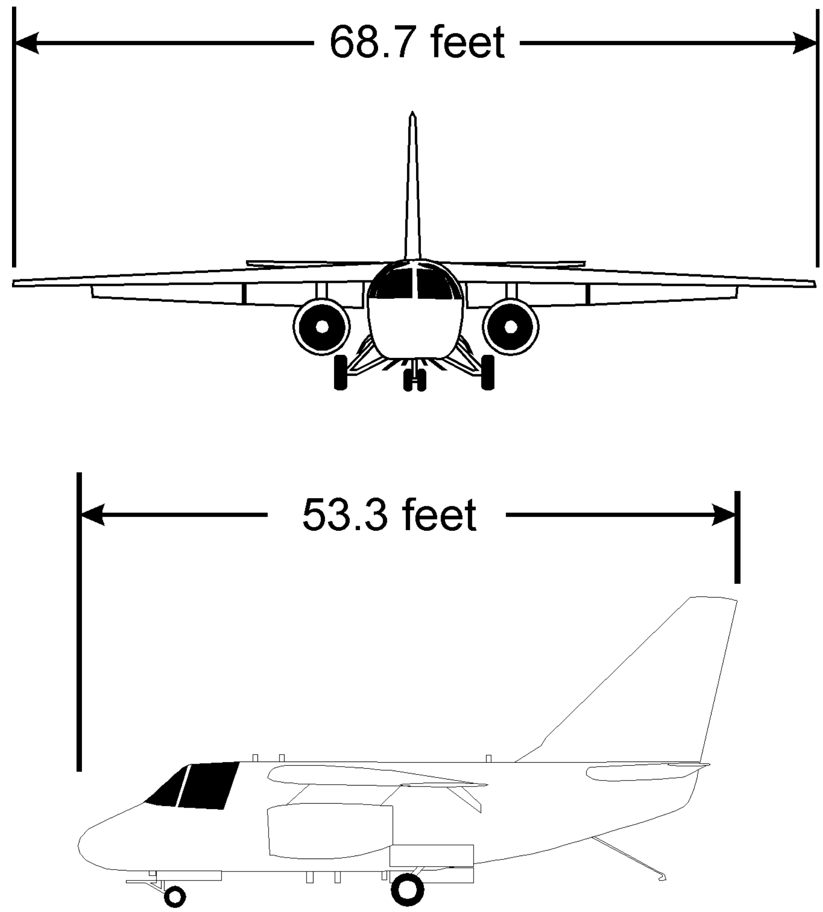


Figure 21-3 S-3A/B

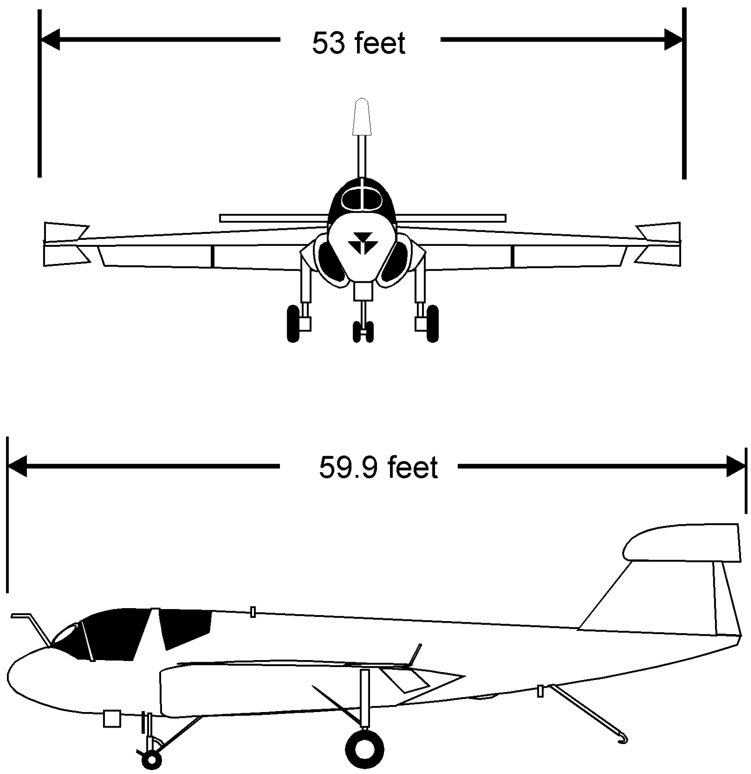
DIMENSIONS	Wing span - 68.7 feet Fuselage - 53.3 feet, H/E - 14.5 feet Basic weight - 29,200 pounds Landing configuration: - Full flaps - Approach light on - gear down, launch bar up
EXTERNAL LIGHTING	Approach light Wing tip lights Green or red anti-collision light on vertical stabilizer Blue DLC light on nose gear door (often disabled)
APPROACH MODES/AIDS	APCS ICLS ACLS Modes IA/II/III
FUEL	Max trap fuel - 11,000 pounds Day/VFR - 200 pounds per pass Night/IFR - 400 pounds per pass
RESTRICTIONS	Max trap weight - 40,500 pounds

S-3 A/B PERFORMANCE

GLIDESLOPE	Turbofan engines, slightly slow response Nose and power coordination Fair APCS with smooth, small changes DLC used to stop rising ball IC-AR DLC always engaged to allow thrust pitch compensation Very gust responsive
LINEUP	Critical due to wing span Some directional instability
AOA/SPEED	Approximate max trap speed - 116 knots Day - flaps bisect engine nacelles Night - approach light below wing light
WAVEOFF	Excellent response Slow approach speed Slight pitch up on power addition
TENDENCIES	Float IC-AR High coming down in-close (burble) Lineup control difficult Watch for HCDAW, LU
MISHAP TRENDS	Off-center engagements

S-3 A/B MALFUNCTIONS/EMERGENCIES

NO YAW DAMPER	Slight Dutch roll Difficult lineup control
NO DLC	Loss of thrust pitch compensation (rough nose control) Aggravates tendency to float IC-AR
HYDRAULIC FAILURE	#1 system - no wheel brakes, hook retraction, nose wheel steering, DLC #2 system - poses no problem
FLAPS UP	36 knots faster (152 knots) Check WOD Flown with DLC engaged, but not used (excessive sink rates) Nose may be used to influence glideslope
AOA FAILURE	Try APCS
SINGLE ENGINE	Decreased waveoff capability Degraded lineup control Tendency to be high and fast Check H/E
BARRICADE	Max gross weight - 37,700 pounds Max engaging speed - 110 knots Check HTDP



21.5 EA-6B

Figure 21-4 EA-6B

EA-6B DESIGN

DIMENSIONS	Wing span - 53 feet Fuselage - 59.9 feet, H/E - 18.75 feet Basic weight - 34,300 pounds Landing configuration: - Flaps 30°, slats extended - Wing tip speed brakes out, gear down - Approach light on - gear down and locked - Flashing approach light - hook not down, tow link down, nose gear cocked - Cross painted on nose
EXTERNAL LIGHTING	Approach light Wing tip lights Wing pylon lights (port-red/stbd-green)
APPROACH MODES/AIDS	APCS ACLS Mode I ILS Rain removal
FUEL	Max trap fuel - 8,800 pounds Day/VFR - 500 pounds per pass Night/IFR - 800 pounds per pass
RESTRICTIONS	Max trap weight - 45,500 pounds

EA-6B PERFORMANCE

GLIDESLOPE	Turbojet engines, excellent response Thrust axis vertical through CG Control glideslope with power Flaperons may result in settle on lineup
LINEUP	Off-center seating Flaperons cause some directional instability
AOA/SPEED	Approximate max trap speed - 124 knots Good stability Day - horizontal stabilizer below flaps Night - wing and approach light in straight line
WAVEOFF	Excellent response Moderate approach speed Slow waveoff response if aircraft is slow
TENDENCIES	Rough lineup Over-control power Hook-skip bolter (nose attitude)
MISHAP TRENDS	Lineup (speed brake impacts deck on late lineup)

EA-6B MALFUNCTIONS/EMERGENCIES

NO SLATS AND NORMAL FLAPS (30°)	14 knots faster Check H/E, WOD
NO FLAPS AND NO SLATS/ NO FLAPS WITH SLATS	45 knots faster Check H/E, WOD
TOW LINK DOWN	Divert or barricade Strip 3 and 4 wires
HYDRAULIC FAILURES	Emergency gear extension Wheel brakes lost AFCS inoperative Speed brakes inoperative
SINGLE ENGINE	Reduced waveoff response AOA system unusable with right engine failure May require stores jettison 20° flaps, check H/E
BARRICADE	Max gross weight - 45,500 pounds Max engaging speed - 110 knots Retain pods and empty tanks Nose wheel on deck (probe) Check HTDP, WOD

21.6 F-14A/B/D

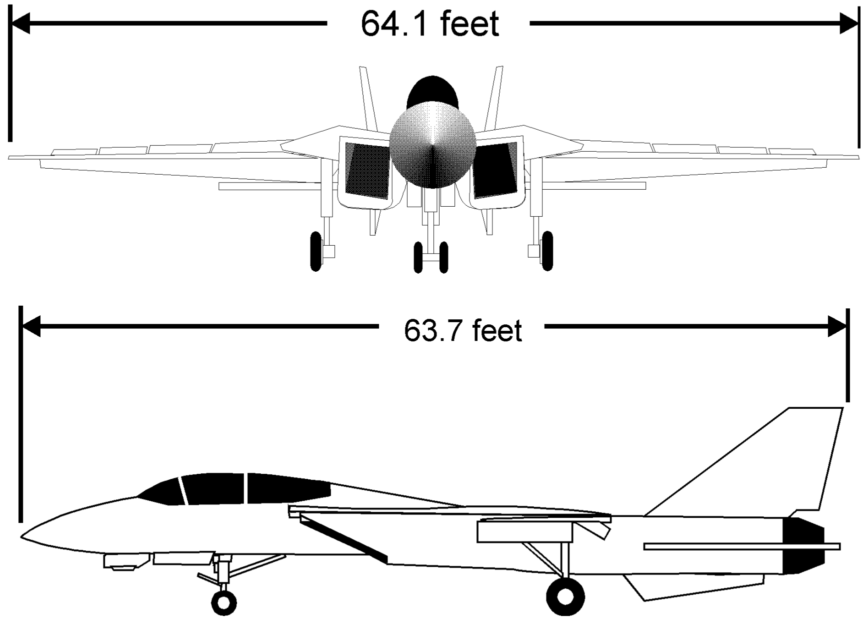


Figure 21-5 F14A/B/D

F-14-A DESIGN

DIMENSIONS	Wing span - 64.1 feet Fuselage - 63.7 feet, H/E - 19.7 feet Basic weight - 44,000 pounds Landing configuration: - Flaps, slats, and speed brakes extended
EXTERNAL LIGHTING	Approach light Wing tip lights - if not illuminated, wings not forward Glove vane lights
APPROACH MODES/AIDS	APCS ICLS ACLS Modes I/IA/II/III DLC
FUEL	Max trap fuel - 10,000 pounds (CQ only) Day/VFR - 400 pounds per pass Night/IFR - 800 pounds per pass
RESTRICTIONS	Max trap weight - 54,000 pounds

F14B/D DESIGN (difference data)

DIMENSIONS	Basic weight - 46,000 pounds
FUEL	Max trap fuel - 10,000 pounds Day/VFR - 500 pounds per pass Night/IFR - 900 pounds per pass

F-14A PERFORMANCE

GLIDESLOPE	Turbofan engines, fair response Nose and power coordination Poor APCS Excellent DLC Gust responsive Problem with nose drop in-close Hard landings and ramp strikes in high coming down situations
LINEUP	Critical due to wing span Some directional instability (Dutch roll)
AOA/SPEED	Approximate max trap speed - 136 knots Appears cocked up Day - nose wheel level with lower left intake Night - approach and glove vane lights slightly above wing tip lights - Port anti-collision light above port glove vane
WAVEOFF	Poor engine response with power back Watch for overrotation - no more than 152 units AOA Slow afterburner response
TENDENCIES	Drop nose High coming down Chase lineup Catch early wires due to high sink rates
MISHAP TRENDS	Ramp strikes/hook slaps Hard landings Lineup drift-related mishaps

F-14B/D PERFORMANCE (difference data)

GLIDESLOPE	Better engine response than F-14A
AOA/SPEED	Approximate max trap speed - 140 knots
WAVEOFF	Better engine response than F-14A Better afterburner performance

F-14A MALFUNCTIONS/EMERGENCIES

NO DLC	More gust responsive Reduced power setting/decreased airspeed (minus 8 knots) Waveoff earlier
NO AUX FLAPS	Aircrew may not know Slightly faster (plus 6 knots) Check wings full forward
FLAPS UP	Back on power - influences glideslope with nose Verify approach speed Check H/E, WOD
WING SWEEP AFT	35° max Aux flaps and possibly main flaps will be up Verify approach speed Check H/E, WOD
LAUNCH BAR DOWN	Strip 1 and 4 wires
NO BOOSTED THROTTLES	Degraded power control, more force required Be prepared for larger glideslope deviations
SINGLE ENGINE	AOA 14 units, no DLC Decreased waveoff capability Directional instability Requires more rudder Check H/E
BARRICADE	Max gross weight - 51,800 pounds Max engaging speed - 108 knots Jettison most stores Wing sweep forward of 35° Check HTDP, WOD

F-14B/D MALFUNCTIONS/EMERGENCIES (difference data)

SINGLE ENGINE	15 units with DLC if left engine on line 14 units no DLC if right engine on line

21.7 F/A-18 A/B/C/D

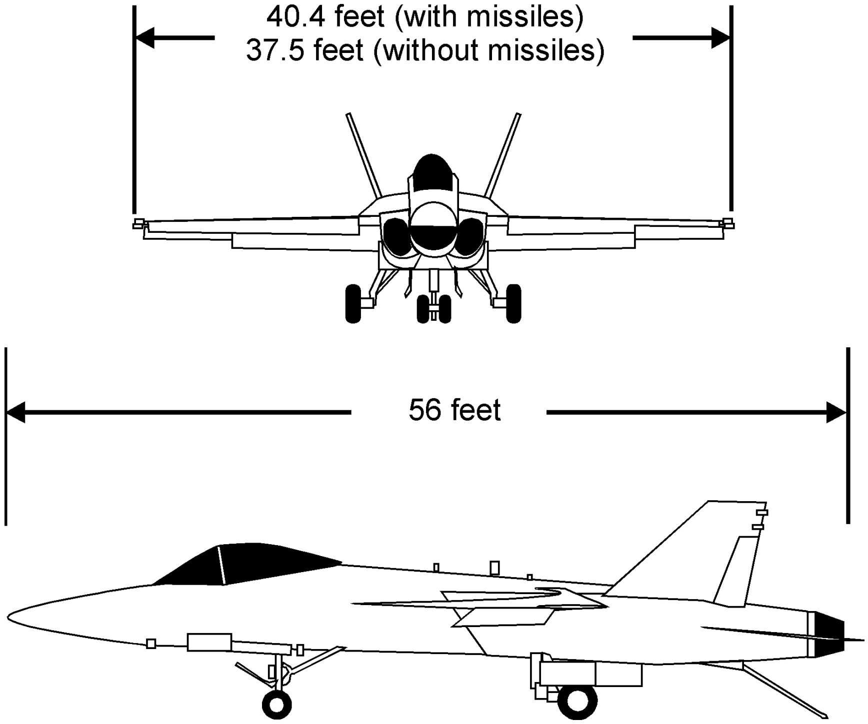


Figure 21-6 F/A-18A/B/C/D

F/A-18A/B/C/D DESIGN

DIMENSIONS	Wing span - 40.4 feet with missiles, 37.5 feet without missiles Fuselage - 56 feet, H/E - 16.7 feet Basic weight - 24,500 pounds Landing configuration: - Flaps extended full down - Approach light on - gear down
EXTERNAL LIGHTING	Approach light Wing tip lights Pylon lights Red strobe lights top of each vertical stabilizer
APPROACH MODES/AIDS	APCS ICLS ACLS Modes I/IA/II/III HUD
FUEL	Max trap fuel - 8,500 pounds Day/VFR - 300 to 400 pounds per pass Night/IFR - 800 to 1,000 pounds per pass
RESTRICTIONS	Max trap weight - 33,000/34,000 pounds (check ARBs)

F/A-18A/B/C/D PERFORMANCE

GLIDESLOPE	Turbofan engines, good response Control glideslope with power Excellent APCS Low gust responsiveness due high approach speed and wing loading Settle on lineup corrections
LINEUP	Favorable control due to forward visibility and small wing span
AOA/SPEED	Approximate max trap speed - 146 knots Good stability Day - top of canopy level with right vertical stabilizer Night - approach light in line with wing tip lights
WAVEOFF	Good engine response High approach speed, waveoff window extended May consider extending waveoff window for APCS approach
TENDENCIES	Settle on lineup Nose down correction for high
MISHAP TRENDS	High coming down on lineup correction Off-center landings

F/A-18A/B/C/D MALFUNCTIONS/EMERGENCIES

HYDRAULIC FAILURE	#2A or 2B - no wheel brakes or nose wheel steering **#1A or 1B - carrier landing prohibited**
NO FLAPS	**Aircraft not recoverable** due to excessive WOD requirement
NO HUD	Primary attitude and AOA information lost, pilot scan degraded
STANDBY ATTITUDE MODE	Use of backup attitude reference severely degrades pilot scan
SINGLE ENGINE	Half flaps Reasonable waveoff capability May experience yaw problems when slow
BARRICADE	Max gross weight - 33,000 pounds Max engaging speed - 135 knots Check HTDP, WOD

21.8 T-45

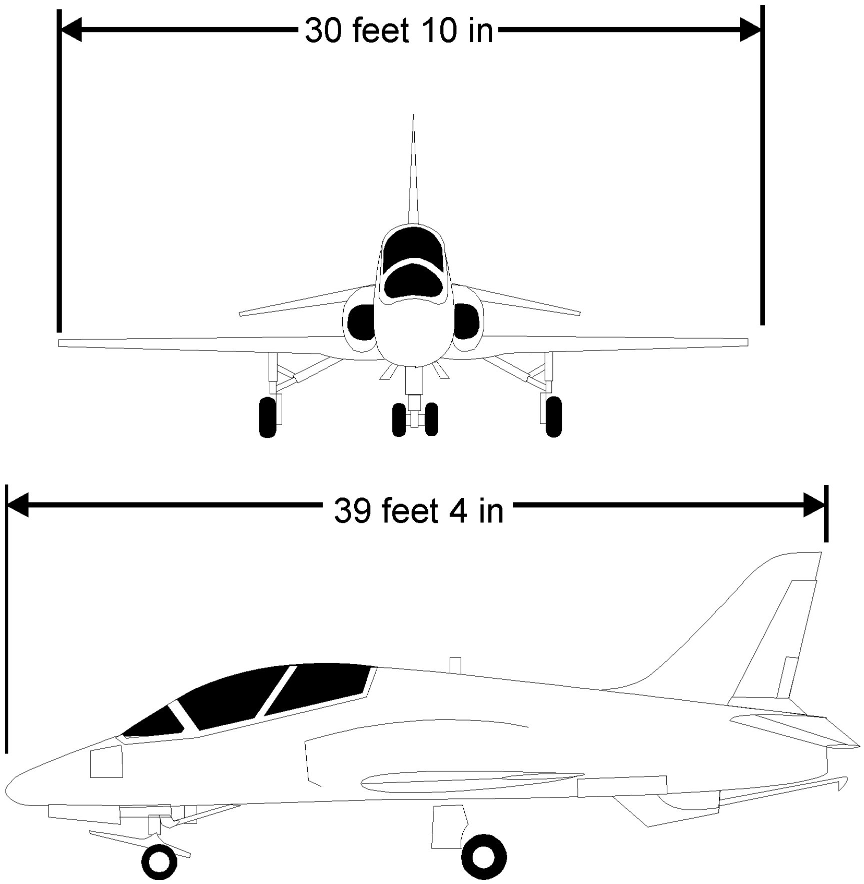


Figure 21-7 T-45

T-45 DESIGN

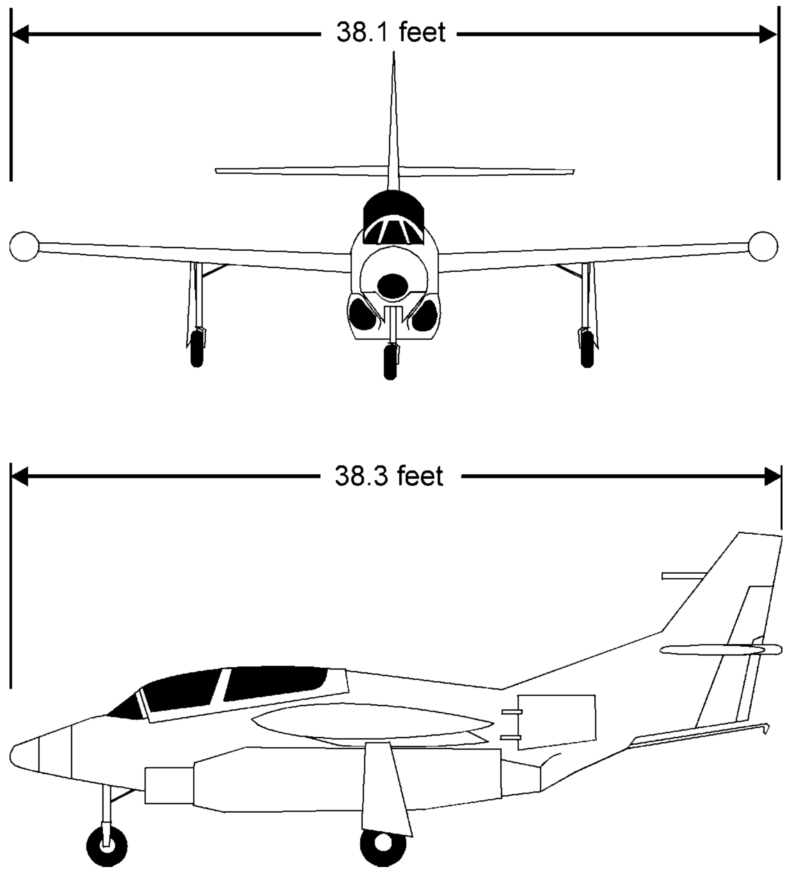
DIMENSIONS	Wing span - 30.8 feet Fuselage - 39.3 feet, H/E - 12.0 feet Basic weight - 10,403 pounds Landing configuration: flaps, slats, and speed brakes extended
EXTERNAL LIGHTING	Approach light Wing tip lights
APPROACH MODES/AIDS	No needles or bullseye; civilian ILS only HUD
FUEL	Max trap fuel - 2,957 pounds => gross wight 13,360 pounds Day/VFR - 200 pounds per pass Night/IFR - NA

T-45 PERFORMANCE

GLIDESLOPE	Turbofan engine - slow spool-up time
LINEUP	Small aircraft Slow approach speed No real problems/tendencies
AOA/SPEED	Approximate max trap speed - 125 knots On speed => 17 units
TENDENCIES	Slick aircraft - overpower, especially IC, difficult to correct for Power controls glideslope - use of nose to influence aircraft is valid/taught technique
MISHAP TRENDS	Blown tires on cat and traps

T-45 MALFUNCTIONS/EMERGENCIES

BARRICADE	**Barricade recovery of T-45 not recommended**



21.9 T-2C

Figure 21-9 T-2C

T-2C DESIGN

DIMENSIONS	Wing span - 38.1 feet Fuselage - 38.3 feet, H/E - 14.8 feet Basic weight - 8,115 pounds
EXTERNAL LIGHTING	Approach light Wing tip lights White lights on each gear - gear down and locked
FUEL	Day/VFR - 250 pounds per pass 70 nm bingo - 1,700 pounds

T-2C PERFORMANCE

GLIDESLOPE	On power additions attitude increase if AOA not 15 units Power decrease may result in nose down
AOA/SPEED	Approximate max trap speed - 94 knots Day - horizontal stabilizer splits canopy windscreen in half
WAVEOFF	Excellent response Slight tendency to over-rotate

T-2C MALFUNCTIONS/EMERGENCIES

ELECTRICAL FAILURE	Major problem if flaps down Pilot should fly airspeed since AOA not available Speed brakes disabled Dual failure - radios available on battery
HYDRAULIC FAILURE	Elevator and aileron revert to manual Strong stick pressure required If hydraulic boost switch not turned, strong pitch movements may be encountered
SINGLE ENGINE	Satisfactory at low fuel states (>2,500 pounds) Response is slow Flown at 14 units vice 15 units and 2 flaps Waveoff performed through momentary increase to 16 units Half flaps and no flap engagements not permitted
BARRICADE	**Barricade recovery of aircraft not recommended**

APPROACH LIGHT GOUGE

A/C	APPROACH LIGHT STEADY	APPROACH LIGHT FLASHING	NO APPROACH LIGHT
E-2	Gear down and locked	Hook up	Gear **NOT** down and locked
C-2	Gear down and locked	Hook up	Gear **NOT** down and locked
S-3	Gear down and locked	Hook up	Gear **NOT** down and locked or launch bar down
EA-6B	Gear down and locked	Hook up or tow link down or cocked nose gear	Gear **NOT** down and locked
F-14	Nose gear down (with glove vane lights and wing tip lights, gear is down)	Hook up	Nose gear **NOT** down
F/A-18	Gear down and locked	Hook up	Gear **NOT** down and locked

Figure 21-10 Approach Light Gouge

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CHAPTER 22

Carrier and Field Service Units

22.1 GENERAL

Carrier and Field Service Unit (CAFSU) representatives are positioned at each major naval ship repair facility to provide installation of modifications and timely repair of carrier landing aids in event of malfunction or casualty. CAFSUs are the field representatives of the Naval Air Engineering Center. They install, service and certify the arresting gear, catapults, FLOLS and IFLOLS, SPN, PLAT, and LSO platform on all carriers as well as comparable shore-based equipment at each Naval Air Station. Since they install and certify all your equipment- and each carrier is different - CAFSU representative are the experts. If there is some conflict or you can't get the expertise or cooperation from the Air Boss, V-2 officer, FLOLS/IFLOLS Officer, or Aircraft Handler, the CAFSU people are the ones who can give you an answer. A CAFSU representative should be within 24 hours of the ship, wherever you are.

22.2 SERVICE UNITS

FLEET TECHNICAL SERVICE DEPARTMENT
FTSD, BLDG. #596
NAVAL AIR ENGINEERING CENTER
LAKEHURST, NJ 08733-5000
COMMERCIAL: (732) 323-7961/1569/2894
DSN 624-7961/1569/2894
DUTY PHONE (AFTER HOURS) DSN 624-2308

*These numbers will change when Lakehurst closes

22.2.1 Eastern Division

CAFSU AIRLANT
NAWCAD Field Office DET FTS
COMNAVAIRLANT (Code N433C)
1279 Franklin Street
Norfolk, VA 23522-2494
(757) 445-5239
DSN 565-5239
FAX (757) 444-8267
FAX (DSN) 564-8267

NORFOLK, VA CAFSU
Bldg R-56
(757) 444-8013 (also FAX#)
Bldg V-15
(757) 444-8608
FAX (757) 445-1731

MAYPORT, FL
NAWCADLKE DET FTS
P.O. Box 280066
U.S. Naval Station, Bldg P160
Mayport, FL 32228-0066
(904) 270-5297/8
DSN 960-5297/8
FAX (904) 270-5025

PORTSMOUTH, VA (CAFSU)
NAWCADLKE DET FTS
St. Julians Creek Annex
Norfolk, Naval Shipyard, Bldg 69
Portsmouth, VA 23702-5001
(757)396-0245/6/7
DSN 961-0245/6/7
FAX (757) 396-0176

NEWPORT NEWS, VA (CAFSU)
Supervisor of Shipbuilding, Bldg 2
Conversion & Repair, USN Code 151
Newport News, VA 23607-2785
(757) 688-1819
FAX (757) 688-3998

22.2.2 Western Division

CAFSU AIRPAC
NAWCAD Field Office DET FTS
COMNAVAIRPAC (Code N435)
P.). Box 357051
San Diego, CA 92135-7051
(619) 545-1499
DSN 735-1499
FAX (619) 545-1500

SAN DIEGO, CA (CAFSU)
Bldg 247
(619) 545-8464
DSN 735-8464
FAX (619) 545-8463

BREMERTON, WA (CAFSU)
NAWCADLKE DET FTS
Puget Sound Naval Shipyard
Code 260.C
Bremerton, WA 98314-1790
(360) 476-3258/3314
DSN 439-3258/3314
FAX (360) 476-1790

22.2.3 Overseas

YOKOSUKA, JA (CAFSU)
NAWCADLKE DET FTS
PSC 473, Box 8
FPO AP 96349-1400
COMM 011-81-31174-37168/37995
DSN (315) 234-7168
FAX 011-81-31174-37168/37851

22.2.4 Fleet Response Division

CHERRY POINT
NAWC Field Officer Det FTS
Second Marine Wing, Wing G-4
attn: SATS Officer, Code SC-15
MCAS Cherry Point, NC 28533-6001
DSN 582-2937-3806

HAWAII
NAWC Field Officer Det FTS
C/O COMNAVSURFGRU MIDPAC
ASIR CODE N6
1000 N RD
Pearl Harbor, HI 96860-4460
COMM: (808) 473-0788

CHAPTER 23

LSO PUBLICATIONS ORDERING INFORMATION

23.1 GENERAL

To order LSO publications (CV NATOPS, LSO NATOPS, ARBs, etc), consult with your command=s Technical Publications Librarian (TPL). This billet is mandatory for all NAVAIR activities so someone in your squadron, staff, etc will be assigned this duty. The following information will familiarize you, however, with the procedures/points of contact for ordering/automatically receiving updated publications.

23.2 ORDERING

The Naval Air Technical Data and Engineering Service Command (NATEC) is located at NAS North Island, CA. (It was established in October 1998 to combine the two former commands NAESU and NATSF). NATEC distributes Technical Publications Library Information Sheets (TPLIS) which provide your command=s TPL with the latest information concerning the ordering, latest updates, and automatic distribution of NAVAIR publications. The document NAVAIR 00-25-100 is the catalog for ordering all NAVAIR publications.

23.3 AUTOMATIC DISTRIBUTION

As the name implies, this process allows commands to automatically receive updated publications as requested on their Automatic Distribution Requirements List (ADRL). This function should already be established through your TPL. It is your responsibility, however, to ensure he/she has included your LSO requirements on the command=s ADRL.

23.4 FURTHER INFORMATION

The latest TPLIS is available on the NATEC web site at www.natec.navy.mil. The Fleet / Customer Liaison phone number at NATEC is (619) 545-2357 or DSN 735-2357

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CHAPTER 24

LSO QUALIFICATIONS CORRESPONDENCE

24.1 GENERAL

The qualification correspondence contained in this chapter has been agreed to by the respective type commanders (COMNAVAIRLANT, COMNAVAIRPAC, CNATRA) and the Marine Corps in 1988. Since that time slight variations in the format may have occurred, but those contained herein are accepted by all type commanders.

A brief summary of the current system of qualification correspondence is as follows:

1. Nominations of individuals for LSO training are initiated at the squadron level, endorsed by the Air Wing/Training Wing Commander, and approved by the type commander (COMNAVAIRLANT, COMNAVAIRPAC, CNATRA as appropriate). Figures 24-1 and 24-2 are samples of nomination letters.

2. LSO Field Qualifications are approved/granted by the Air Wing Commander (figure 24-3).

3. Subsequent LSO qualification recommendations (squadron, wing, and staff) are initiated by the air wing commander and approved by the type commander. A single letter from the Air Wing commander may include several individuals and multiple qualification recommendations (figure 24-4).

4. LSO Training Qualification recommendations are initiated by the individual's FRS or TRACOM squadron, endorsed by the type wing, or training Wing Commander (if required), and approved/ granted by the type commander (figure 24-5).

5. Endorsements to all qualification correspondence, when required, should be included as a single page endorsement with the original nomination/recommendation letter (figure 24-6).

6. Appropriate LSO Additional Qualification Designators (ADQs) will be assigned through N1, DCNO for Manpower and Personnel by the type commander upon approval of a qualification recommendation. See chapter 25 for a discussion of ADQs.

7. Should it be necessary to remove an LSO's designation, the LSO's commanding officer shall forward a letter requesting such action (figure 24-7) via the chain of command to:

Department of the Navy
Bureau of Naval Personnel
5720 Integrity Drive
Millington, TN 38055-4320
Attn: Pers-433A

Reasons for removing such designations shall be cited.

DEPARTMENT OF THE NAVY

FIGHTER SQUADRON TWO ONE THREE
FLEET POST OFFICE
NEW YORK 09504-6219

IN REPLY REFER TO:

1200
Ser 00/
10 July 1999

From: Commanding Officer, Fighter Squadron TWO ONE THREE
To: Commander Naval Air Force, U.S. Atlantic Fleet
Via: Commander, Carrier Air Wing ONE

Subj: NOMINATION FOR LANDING SIGNAL OFFICER (LSO) TRAINING

Ref: (a) LSO NATOPS

1. In accordance with reference (a), the following information is submitted:

   a. SLACK, Maxwell N., LT, USN, 123-45-6789/1310

   b. Date of Rank: 13 January 1998

2. Reported: 12 November 1998/PRD: November 2002

3. Total Hours/Hours in type: 425/300

4. Total Carrier Landings (D/N/T): 30/10/40

J. LUFBERRY

---

14 July 1999

FIRST ENDORSEMENT

From: Commander, Carrier Air Wing ONE
To: Commander Naval Air Force, U.S. Atlantic Fleet

1. Forwarded, recommending approval.

T. LARSON

Copy to:
LSO School
Service Record

Figure 24-1 Sample Letter of Nomination

DEPARTMENT OF THE NAVY

COMMANDER NAVAL AIR FORCE
UNITED STATES ATLANTIC FLEET
NORFOLK, VA. 23511-5188

IN REPLY REFER TO:

1200
Ser 355/
21 July 1999

From: Commander Naval Air Force, U.S. Atlantic Fleet
To: Bureau of Naval Personnel (PERS-433A)*

Subj: INDIVIDUALS AUTHORIZED FOR LANDING SIGNAL OFFICER TRAINING

1. By copy of this letter, authority is granted to train the following officers as LSOs:

Name/Rank/SSN	Squadron	Qual
SLACK, Maxwell N., LT, 123-45-6789	VF-213	Nomination
TALLMAN, William D., LT, 469-38-2142	VFA-86	Nomination

R. A. LOWE
By direction

Copy to:
CVW-1
VF-213
VFA-86
LSO School
Service Record

*Note - PERS 433B for COMNAVAIRPAC units.

Figure 24-2 Sample Letter of Nomination Approval

DEPARTMENT OF THE NAVY

COMMANDER CARRIER AIRWING ONE
FPO NEW YORK, 09504-4400

IN REPLY REFER TO:

1200
Ser 00/
10 April 1999

From: Commander, Carrier Air Wing ONE
To: Commander Naval Air Force, U.S. Atlantic Fleet

Subj: LANDING SIGNAL OFFICER QUALIFICATION

1. The following LSO Field Qualification is granted:

Name/Rank/SSN	SQDN	IFGT
JONES, Robert, LT, 266-23-6446	VFA-136	03/99*

T. LARSON

Copy to:
PERS-433A
VFA-136
LSO School

* NOTE - If LSO has not attended Initial Formal Ground Training (IFGT), then a statement must be included that he has received instruction in the required subject areas specified in paragraph 10.2.1 of LSO NATOPS.

Figure 24-3 Sample Field Designation

DEPARTMENT OF THE NAVY

COMMANDER CARRIER AIRWING ONE
FPO NEW YORK, 09504-4400

IN REPLY REFER TO:

1200
Ser 00/
10 June 1999

From: Commander, Carrier Air Wing ONE
To: Commander Naval Air Force, U.S. Atlantic Fleet

Subj: LSO QUALIFICATIONS/RECOMMENDATIONS

1. The following LSO Qualifications are recommended:

STAFF

Name/Rank/SSN	Unit	AFGT
CALDWELL, Timothy, LT, 064-58-1940	CVW-1	03/99

WING

Name/Rank/SSN	Unit	IFGT
SMITH, Patrick, LT, 239-60-6704	VAW-123	04/99

SQUADRON

Name/Rank/SSN	Unit	IFGT
COLLINS, John, LT, 289-14-2599	VFA-86	02/99*
ADAMS, Jeffrey, LT, 457-18-4223	VS-32	12/98

T. LARSON

Copy to:
VFA-86
VAW-123
VS-32
LSO School
Service Record

*NOTE - If LSO has not attended Initial Formal Ground Training (IFGT), then a statement must be included that he has received instruction in the required subject areas specified in paragraph 10.3.1 of LSO NATOPS.

Figure 24-4 Sample Qualification Recommendation (Staff, Wing, Squadron)

DEPARTMENT OF THE NAVY

COMMANDER NAVAL AIR FORCE
UNITED STATES ATLANTIC FLEET
NORFOLK, VA. 23511-5188

IN REPLY REFER TO:

1200
Ser 00/
03 July 1999

From: Commander Naval Air Force, U.S. Atlantic Fleet
To: Bureau of Naval Personnel (PERS-433A)*

Subj: DESIGNATION OF LANDING SIGNAL OFFICERS (LSOs)

1. By copy of this letter, the following LSO designations are granted:

Name/Rank/SSN	Squadron	Qual	AQD
CALDWELL, Timothy, LT, 064-58-1940	CVW-1	Staff	EFD
BUCKMORE, Robert, LT, 503-68-6269	VFA-106	Training	ED4
SMITH, Patrick, LT, 239-60-6704	VAW-123	Wing	EC8
ADAMS, Jeffrey, LT, 457-18-4223	VS-32	Squadron	EBF
COLLINS, John, LT, 289-14-2599	VFA-86	Squadron	EBY
MCGHIE, Richard, LT, 129-15-6631	VF-11	Squadron	EBD
WILLIAMS, James, LT, 215-74-6960	VFA-37	Squadron	EB4

R. A. LOWE
By direction

Copy to:
CVW-1
CVW-6
VFA-106
VAW-123
VFA-86
VS-32
VFA-37
VF-11
LSO School
Service Record

* NOTE - PERS 433B for COMNAVAIRPAC units.

Figure 24-5 Sample LSO Designation (Staff, Training, Wing, Squadron)

DEPARTMENT OF THE NAVY

FIGHTER SQUADRON ONE ZERO ONE
NAVAL AIR STATION OCEANA
VIRGINIA BEACH, VA . 23460

IN REPLY REFER TO:

1200
Ser 00/
10 April 1999

From: Commanding Officer, Fighter Squadron ONE ZERO ONE
To: Commander Naval Air Force, U.S. Atlantic Fleet
Via: (If required, see Note)

Subj: TRAINING LANDING SIGNAL OFFICER (LSO) RECOMMENDATION

1. The following LSO is recommended for a Training LSO Qualification:

Name/Rank/SSN	F/TFGT
DAHLGREN, Jeffrey, LT, 197-26-2101	02/99

R. J. CROMWELL

-- --

14 April 1999

FIRST ENDORSEMENT (If required, see Note)

From: (Functional Wing or Training Wing Commander)
To: (Type Commander)

1. Forwarded, recommending approval.

I. C. STARS

Copy to:
LSO School
Service Record

NOTE: COMNAVAIRPAC units submit via functional wing commander for endorsement; CNATRA units submit via training wing commander for endorsement; COMNAVAIRLANT units require no endorsement.

Figure 24-6 Sample LSO Training Recommendation

DEPARTMENT OF THE NAVY

FIGHTER SQUADRON TWO ONE THREE
FLEET POST OFFICE
NEW YORK 09504-6219

IN REPLY REFER TO:

1200
Ser 00/
12 May 1999

From: Commanding Officer, Fighter Squadron TWO ONE THREE
To: Bureau of Naval Personnel (PERS-433A)*
Via: (1) Commander, Carrier Air Wing ONE
(2) Commander Naval Air Force, U.S. Atlantic Fleet

Subj: REMOVAL OF LANDING SIGNAL OFFICER (LSO) DESIGNATION ICO
LT MICHAEL J. WILFORD, USN, 297-38-2589/1310

Ref: (a) LSO NATOPS

1. LT Wilford's desire and performance do not meet the standards prescribed by reference (a).

2. In order to preclude further detailing of LT Wilford to a Landing Signal Officer billet, it is recommended that his designation as a Squadron qualified LSO be removed.

J. LUFBERRY

Copy to:
LSO School
Service Record

*Note - PERS 433B for COMNAVAIRPAC units.

Figure 24-7 Sample LSO Designation Removal

CHAPTER 25

LSO Additional Qualification Designator (AQDs)

25.1 GENERAL

The source for LSO Additional Qualification Designation (AQD) is NAVPERS 158839I, Manual of Navy Officer Manpower and Personnel Classifications.

25.2 Application

AQD Codes enhance officer and billet designator codes by more specifically identifying the qualifications of officers and the qualifications required by billet. AQDs consist of the characters, either alpha-numeric or all numeric. The first character identifies a broad occupational area closely related to the designator. The second character specifies the qualifications appropriate to the occupational area, with the third character further defining the specific qualifications. LSO AQDs are assigned upon type commander approval of LSO qualification recommendations. They will appear in block 72 of the Officers Data Card (ODC), distributed annually to all officers. The form should be checked closely for accuracy and currency. A sample Block 72 is illustrated below.

25.3 Example

All LSO AQDs begin with "E."

1. F-14 Squadron Qualified LSO (EDB)
2. T-45 Training Qualified LSO (ED)
3. F/A-18 Wing Qualified LSO (ECY)

SAMPLE ODC BLOCK 72

Additional Qualification Designation	
Code Yr	Title
EAD 98	LSO TRV F-14
EBY 97	LSO SQV F/A-18
EC5 97	LSO WQV EA-6B
EFK 98	SFV F14,S3
EU	LSO SCHL INT
EZ	LSO SCHL GRD

Mission Class	First Char	Second Char		Third Char	
		Code	Type Qual	Code	A/C qual
LSO	E	A	FLD (Field Qualified)*	1	
		B	SQV (Squadron LSO CV)*	2	TA4J
		C	WQV (Wing LSO CV)*	4	
		D	TRV (Training LSO CV)*	5	EA6B
		F	SFV (Staff LSO CV)*	6	
		H	VTI (VT LSO CAT I)**	7	
		J	VTII (VT LSO CAT II)**	8	C2,E2
		K	VTIII (VT LSO CAT III)*	A	
		Y	LSO SCHL GRD+	B	
		U	LSO SCHL INT+++	D	F14
		Z	LSO SCHL GRD++	F	S3
				G	T2
				J	S3
				K	F14,S3
				U	OTHER
				Y	FA18
				Z	T2,TA4

* Qualification criteria for second character A through F are prescribed in LSO NATOPS Manual.

** Qualification criteria for second character H through K are prescribed in CNATRAINST 1520.5 series.

+ LSO School graduate ordered to LSO School immediately after designation as Naval Aviator.

++ All LSO School graduates with exception of (+) above.

+++ LSO School instructor.

CHAPTER 26

Marine Corps LSO Program

26.1 GENERAL

MCO 1540.32B is an order whose purpose is to emphasize the need for USMC LSO's and to provide instructions and policy for their training, assignments, and management.

26.2 USMC LSO MOSs

The following MOSs apply to Marine Corps LSOs and are applicable as follows:

MOS	LSO Qualification Equivalent
7590	LSO Trainee
7594	Squadron Qualified LSO

NOTE

There are no provisions for additional MOSs for field, wing, or training qualified LSOs.

26.3 MARINE CORPS LSO EXCHANGE PROGRAM

Because of limited LSO training opportunities within the Marine Corps, a Navy Exchange Program exists for advanced training of Marine LSOs. The normal tour length is approximately 24 months. At the completion of the exchange tour, individuals can expect a wing qualification. Marines who are interested in an exchange tour should contact at the U.S. Navy LSO School.

CHAPTER 27

Sample LSO Mishap Statement

27.1 GENERAL

Sources: LSO NATOPS; OPNAVINST 3750.6 (Naval Aviation Safety Program)

It is incumbent upon the LSO to prepare detailed and complete statements regarding aircraft mishaps for use by Aircraft Mishap Investigation Boards (AMB). The LSO is usually in the best position to evaluate incidents culminating in carrier landing mishaps/incidents. Below is an outline of items that are pertinent to most CV landing mishaps.

27.2 LSO MISHAP STATEMENT FORMAT

LSOs shall be afforded access to the PLAT tape, with sound, prior to preparing any statements.

27.2.1 Narrative

1. State, as you saw them, the events as they occurred.

2. Include explanation of your actions taken.

27.2.2 Environmental Factors

1. Weather: Include both observed and "LSO called".

2. Deck conditions: Include list, Dutchroll, deck movement in feet, periodicity, heave.

3. Wind: Both direction and velocity, gusts, shears, "sink holes", turbulence in the groove, shifting direction, crosswind component.

4. LSO equipment: State what was working and what was inoperative, and if all problems were passed to the Air Boss. State if any of the inoperative gear could have had an effect on the recovery.

5. LSO horizon: State what was being used as horizon reference (destroyer position, flares, helo, nothing, etc.).

6. FLOLS intensity settings, status of deck and drop light landing area lights.

27.2.3 Air Operations

1. Had the LSO advised to cancel flight operations prior to the mishap?

2. Were AIROPS canceled after the mishap?

27.2.4 LSO Data

1. Type qual, date received, aircraft qualified to wave at the field, ship, day, night, MOVLAS experience.

2. Date of last formal training.

3. Time in LSO duty status for that day, physical condition, fatigue factor.

4. State your warfare specialty, type aircraft qualified in as a pilot.

5. State any other aircraft qualified in as a pilot, cross-trained in, received FAM/ orientation flights in.

27.2.5 Pilot Performance

1. Update trend analysis with squadron LSO.

2. Include a narrative of pilot's specific trends.

3. Include a comparison of his performance to that of his "experience level" peers.

27.3 EMBARKED LANDING HAZARD REPORTS

An Embarked Landing Hazard Report shall be submitted utilizing the format outlined in OPNAVINST 3750.6 anytime a part of an aircraft impacts on or below the round down; a part of an aircraft other than the landing gear and/or hook impacts the landing area; or an aircraft impacts other aircraft, personnel or equipment on the flight deck.

CHAPTER 28

SAMPLE LSO ADMAT GUIDE

28.1 GENERAL

Following the guide below will ensure basic, sound LSO program ready for any inspection.

I. LSO MANNING

A. Minimum Number Qualified/Under Training (IAW LSO NATOPS)

1. Nomination Letters
2. Qualification/ Designation Letters
3. Log Book and Training Jacket Entries

II. AIRCREW TRAINING

A. Lecture Syllabus (IAW LSO/CV NATOPS)

1. FCLP Lectures
2. Simulator Lectures
3. Pre-carrier Briefings

B..Simulator Training/Syllabus

C. Aircrew Exams

III. CURRENT PUBLICATIONS

A. LSO NATOPS

B. CV NATOPS

C. Appropriate Airwing Instructions/TACNOTES

1. Airwing LSO SOP Training/Instructions

D. Type Commander CQ/LSO Instructions

E. Aircraft Recovery Bulletins (OPTIONAL - copies for training purposes only)

1. ARB 0-11
2. ARB 10-10
3. ARB 12-12
4. ARB 29-12/13
5. ARB 62-12

F. LSO Reference Manual

G. Flight Deck Awareness Pamphlet (Naval Safety Center)

IV. LSO ADMINISTRATION

A. Turnaround Training Plan

1. LSO School Formal Ground Training as required.
2. LSO Trainer utilization

B. Lecture Attendance Records

C. FCLP Records

2. FCLP Trends
3. "Safe for CQ" Memorandum to C.O. via Ops O.

D. Pilot Trend Analysis Sheets(including last extended deployment.)/APARTS

E. LSO Training Status Matrix

CHAPTER 29

LSO Personal Equipment

29.1 GENERAL

Some of the clothing and survival equipment available to the LSO is shown on the following pages. Most stock numbers are still valid, however, have your squadron storekeeper or supply personnel check to make sure.

PLAN AHEAD! Don't wait until you are pulling out from the pier for a NORPAC/NORLANT cruise to check for cold weather gear. It may take 2-3 months to get the equipment you will require to survive in driving snow, rain, and sleet on that place we call home...the platform.

29.2 JERSEY, FLIGHT DECK CREWMAN'S (White LSO Jersey)

Small	00-914-0333
Medium	00-914-0334
Large	00-914-0335
X-Large	00-914-0336

29.3 LIFE PRESERVER, VEST OUTFIT, MARK 1 (LSO Vest)

The following parts are required for a complete vest assembly.

Dual Inflator Assembly	00-012-3571
Bladder Assembly	00-935-5528
CO_2 Cartridge	00-805-8383
Vest Cover (white)	
Small	00-926-9465
Medium	00-926-9472
Large	00-926-9479

29.4 WHISTLE, BALL (Olive Drab)

00-254-8803

29.5 OTHER MISCELLANEOUS CLOTHING/EQUIPMENT

29.5.1. Cap, Cold Weather.
1. Olive green. Permeable cotton and nylon sateen cap. Ski-type style with knitted nylon fleece lining. Equipped with retractable ear and neck extension flap. Part of intermediate Cold Weather Outfit. Spec MIL-C-21709

00-753-5607	Small
00-753-5608	Medium
00-753-5609	Large
00-753-5610	X-Large

2. Olive green cotton nylon oxford cap. Helmet liner insulating type. Acrylic cloth crown lining, nylon fleece ear flaps lining and adjustable forehead flap. May be used without helmet. Cap sizes shown below. Spec MIL-C-43549.

00-782-02916	6 1/2
00-782-02917	6 3/4
00-782-02918	7
00-782-02919	7 1/4
00-782-02920	7 1/2
00-782-02921	7 3/4

29.5.2. Liner, Extreme Cold Weather Parka.
Nylon faced quilted polyester batting liner. Olive green. Single breasted design with button attachment. For use as a button-in liner in extreme cold weather parkas. Part of Extreme Cold Weather outfit. Spec MIL-L-43466

00-782-2881	X-Small
00-782-2882	Small
00-782-2883	Medium
00-782-2884	Large
00-782-2885	X-Large

29.5.3 Hood, Extreme Cold Weather.
1. Universal size. Nylon twill, chloroprene rubber-coated on the underside, nylon fleece knitted lining green. Hook and pile nylon tape fastening. Attached to garment with loops. Waterproof. Spec MIL-H-29101.

00-472-4695	Without earpods

2. Green, impermeable chloroprene rubber-coated nylon twill outer shell with knitted nylon fleece lining. Features a visor, fur ruff and chest slide fastener closure. For use with extreme cold weather jacket, trousers and cap in cold and cold wet areas ashore. Size designation and head size in inches shown below. Spec MIL-H-17024

00-753-5603	Small	6 5/8 - 6 3/4
00-753-5604	Medium	6 7/8 - 7
00-753-5605	Large	7 1/8 - 7 1/4
00-753-5606	X-Large	7 3/8 - 7 1/2

29.5.4 Mask, Extreme Cold Weather.
Olive green, vinyl coated nylon mask with wool felted lining. Waterproof outer surface. Equipped with snap fastened nose and mouth coverings, eyes, nose and mouth openings, a chin piece and a neck shield. Part of Extreme Cold Weather Outfit. Spec MIL-M-3294.

00-243-9844 Universal size

29.5.5 Jacket, Extreme Cold Weather. Green chloroprene rubber-coated nylon twill jacket. Coated on the underside. Features a removable quilted lining, cotton corduroy collar and knitted cuffs. Single breasted design with side fastener closure and buttoned extension flap. For use with extreme cold weather trousers and hood in cold and wet cold areas. The jacket, which is impermeable, is particularly suitable for use by personnel on shipboard water. Part of Extreme Cold Weather Outfit, Spec MIL-J-82299.

00-349-9313	34-36
00-349-9314	38-40
00-349-9315	42-44
00-349-9316	46-48
00-349-9317	50-52

29.5.6 Parka Wet Weather.

1. Lightweight green nylon. Coated both sides with polyurethane plastic. Waist adjust w/drawcord, hood closure w/drawcord and hook-pile fastener tape. For use over existing clothing w/lightweight wet weather trousers. Spec MIL-P-43907.

00-001-1547	X-Small
00-001-1548	Small
00-001-1549	Medium
00-001-1550	Large
00-001-1551	X-Large

2. Olive green, nylon twill cloth. Coated with chloroprene rubber on both aides. Jacket styled with attached hood having adjustable fastener tape neck closure, side take-up straps, foam lined face seal and visor. Features a front slide fastener closure, two patch pockets with flaps, adjustable snap closure on each sleeve bottom and drawstring at waist. Used in conjunction with the wet weather coveralls. Spec MIL-P-82277.

00-051-8390	XX-Small	(26-28)
00-924-7939	X-Small	(30-32)
00-924-7935	Small	(34-36)
00-924-7936	Medium	(38-40
00-924-7937	Large	(40-44)
00-924-7937	X-Large	(46-48)

29.5.7. Parka, Extreme Cold Weather. Olive green cotton and nylon parka. Water repellent treated, single breasted design with slide fastener front closure and snap fastened protective flap. Equipped with draw cords at waist and coat bottom. Furnished without hood or removable liner. Part of Extreme Cold Weather Outfit. Spec MIL-P-13496.

00-782-3216	X-Small
00-782-3217	Small
00-782-3218	Medium
00-782-3219	Large
00-782-3220	X-Large

29.5.8 Overalls, Wet Weather. Olive green nylon twill cloth. Coated with chloroprene rubber on both sides. Designed with bib front, high back style, cotton webbing, suspender straps, and double folded self-closing fly. Features left front patch pocket with flap and snap fastener closure. Leg bottoms and right side have adjustable strap closures. The waterproof overalls are intended for use in conjunction with the wet weather parka for protection when working in wet or wet/cold conditions. Spec MIL-O-22776.

01-052-2914	XX-Small (26-28)
00-782-3255	X-Small (30-32)
00-985-7327	Small (34-36)
00-985-7328	Medium (38-40)
00-985-7329	Large (40-44)
00-985-7330	X-Large (46-48)

29.5.9 Glove Shells, Cold Weather. Brown leather glove shells

29.5.10 Glove Inserts, Cold Weather. Type M-1949. Olive green knitted nylon and wool glove inserts for use with leather glove shells. 8415-00-634-4794. 4793 and 00-269-5700 thru 5702. Ambidextrous design. Knit cuff type closure. Spec MIL-G-835.

00-682-6673	1
00-682-6674	2
00-682-6675	3
00-682-6676	4
00-682-6677	5

29.5.11 Mittens, Extreme Cold Weather. Extreme cold weather mittens. Olive green chloroprene coated nylon cloth outer shell with leather reinforcement on palm. Knitted nylon fleeced cloth interliner and chloroprene coated nylon taffeta inner shell. Equipped with strap and buckle across top of mitten. Part of Extreme Cold Weather Outfit and Submarine Deck Exposure Ensemble. Spec MIL-M-22773.

00-965-1752	Small 71/2 to 8
00-965-1753	Medium 81/2 to 9
00-965-1754	Large 91/2 to 10
00-965-1755	X-Large 101/2 to 11

29.5.12 Mitten Set, Extreme Cold Weather. Extreme cold weather mitten set. Olive green cotton and nylon shell with an alpaca pile fabric back and saddle brown deerskin leather palm. Green cotton and nylon gauntlet and a harness assembly attached to mittens to prevent loss. Part of Extreme Cold Weather Outfit. Spec MIL-M-834.

00-782-6715	Small
00-782-6716	Medium
00-782-6717	Large

29.5.13 Shirt, Cold Weather. Olive green wool and nylon flannel shirt. Coat style button front closure and buttoned sleeve cuffs, a convertible collar, long sleeves and patch pockets with flaps. Part of Cold-Dry and Wet-Cold Outfits.
Spec MOS-S-10858.

00-188-3794
00-188-3792
00-188-3791
00-188-3798
00-188-3793

29.5.14 Jersey, Flight Deck Crewman's. Long sleeve, pullover type cotton jersey. Turtle neck style. For use by flight deck personnel aboard aircraft carriers to designate their assigned duties. Spec MIL-J-82281.

SMALL SIZE

00-914-0312	Blue
00-914-0316	Brown
00-914-0321	Green
00-914-0325	Purple
00-914-0329	Red
00-914-0333	White
00-914-0337	Yellow

MEDIUM SIZE

00-914-0313	Blue
00-914-0317	Brown
00-914-0322	Green
00-914-0326	Purple
00-914-9481	Red
00-914-0334	White
00-914-0338	Yellow

LARGE SIZE

00-914-0314	Blue
00-914-0318	Brown
00-914-0323	Green
00-914-0327	Purple
00-914-0331	Red
00-914-0335	White
00-914-0339	Yellow

EXTRA LARGE SIZE

00-914-0315	Blue
00-914-0319	Brown
00-914-0324	Green
00-914-0328	Purple
00-914-4143	Red
00-914-0336	White
00-914-0340	Yellow

29.5.15. Trousers, Extreme Cold Weather. Green chloroprene rubber-coated nylon twill trousers with knitted nylon fleece lining. Waterproof and insulated. Features a slide fastener and buttoned fly closure. Equipped with belt and suspender loop and adjustable take-up straps near bottom of trousers. Waist size and inseam length in that order, shown below. Part of Extreme Cold Weather Outfit. Spec MIL-T-21705.

00-575-1225	Small	(27-30)
00-575-1230	Medium	(31-34)
00-575-1240	Large	(36-38)
00-575-1246	X-Large	(39-42)
00-575-1247	XX-Large	(43-46)

29.5.16. Trousers, Cold Weather. Cold-wet weather trousers. Field Type. Olive green wool serge. Features a slide fastener fly closure and finished bottoms. Equipped with belt loops, suspender straps, adjustable waist straps and pockets. Part of Cold-Wet Weather Outfit. Spec MIL-T-1870.

00-231-7213	X-Small	Short
00-231-7214	X-Small	Regular
00-231-7207	Small	Short
00-231-7206	Small	Regular
00-231-7205	Small	Long
00-231-7204	Medium	Short
00-231-7203	Medium	Regular

00-231-7202	Medium	Long
00-231-7200	Large	Regular
00-231-7199	Large	Long
00-231-7209	X-Large	Regular
00-231-7208	X-Large	Long

29.5.17 Drawers, Extreme Cold Weather. Natural color cotton, knitted waffle type cloth drawers. Ankle length with rib knit anklets, boxer style fly and an elastic waistband. Part of Cold Weather Outfits. Spec MIL-D-15390.

01-051-1175	X-Small	(23-26)
00-782-3226	Small	(27-30)
00-782-3227	Medium	(31-34)
00-782-3228	Large	(35-38)
00-782-3229	X-Large	(39-42)

29.5.18 Undershirt, Extreme Cold Weather. Natural color, cotton waffle knit undershirt. Rib knit wristlets and collarette. Long sleeves, pullover style. Part of Cold Weather Outfit. Spec MIL-L-17611.

01-051-1174	X-Small
00-270-2012	Small
00-270-2013	Medium
00-270-2014	Large
00-270-2015	X-Large

29.5.19 Socks, Extreme Cold Weather. White wool felt sock. High top design. Size shown below. Spec MIL-S-38004.

00-177-7992	Small
00-177-7992	Medium
00-177-7992	Large

CHAPTER 30

LSO POINTS-OF-CONTACT

30.1 GENERAL

The following points of contact coupled with those in Chapter 22, (Carrier and Field Service Unit) will be sufficient to answer any LSO questions that should arise.

30.2 NAVY

1. LSO SCHOOL

U.S. Navy LSO School
1680 Tomcat Blvd Ste 100
Virginia Beach, Virginia 23460-2189
DSN 433-2515/2530

2. AIRLANT LSO

Commander Naval Air Force
U.S. Atlantic Fleet (Code N83H)
Norfolk, Virginia 23511-5188
DSN 564-2723/Ext 353

3. AIRPAC LSO

Commander Naval Air Force
U.S. Pacific Fleet (Code 311L)
NAS North Island
San Diego, California 92135-5100
DSN 735-1155

4. CNATRA LSO

Chief of Naval Air Training (Code N333)
Naval Air Station
Corpus Christi, Texas 78419-5100
DSN 861-3929

5. AVIATION DETAILERS

Navy Personnel Command (Pers 433)
5720 Integrity Drive
Millington, TN 38055-4400
DSN 882-3695
FAX 882-2664

30.3 MARINE CORPS

1. MARINE LIAISON OFFICER, LSO SCHOOL

U.S. Navy LSO School
1680 Tomcat Blvd Ste 100
Virginia Beach, Virginia 23460-2189
DSN 433-2515/2530

(Advise CMC, Codes ASM, MMOA-2, and MCCDC (TE32A) in LSO matters)

2. COMMANDANT OF THE MARINE CORPS

Headquarters Marine Corps
Washington, D.C. 20380

CODE ASM Aviation Manpower and Support Branch represents DCS (Air) in matters pertaining to LSO selection
DSN 224-1244

CODE MMOA-2 Officer Assignment Branch ensures LSO personnel assets are proportionately distributed to subordinate commands.
DSN 224-2038/2211/1138/2312/2112

3. COMMANDING GENERAL MARINE CORPS DEVELOPMENT COMMAND (MCCDC)

Quantico, Virginia 22134

DEPUTY COMMANDER FOR TRAINING AND EDUCATION/MCCDC (TE32A)
Ensures training of LSOs is accomplished in accordance with LSO NATOPS and MSO

4. SECOND MAW LSO

Second Marine Air Wing (G-3T, LSO)
MCAS Cherry Point
North Carolina 28533-6001
DSN 582-2577

5. THIRD MAW LSO

Third Marine Air Wing (G-3T, LSO)
MCAS Miramar
San Diego, California

6. FIRST MARINE BRIGADE LSO

Marine Aircraft Group 24
1st Marine Amphibious
Brigade, FMF
MCAS Kaneohe Bay, Hawaii
96863-6010

30.4 NAVAL AIR ENGINEERING CENTER, LAKEHURST, NEW JERSEY 08733-5000

Technical information concerning LSO equipment, recovery equipment, FLOLS/ IFLOLS, ARBs, catapults and ship's installations may be obtained through the Launch/Recovery section at NAEC. Some specific points of contact:

Code 4.8.10.3
Optical Landing Aids (FLOLS/IFLOLS, MOVLAS): DSN 624-1828/1811
HUD: DSN 624-2773

Code 4.8.10.4
ARBs: DSN 624-2880)
PLAT (ILARTS): DSN 624-1836
ICOLS: DSN 624-1695

CHAPTER 31

Aircraft Recovery Bulletins

31.1 GENERAL

Aircraft Recovery Bulletins (ARBs) contain the governing instructions for the operational use of arresting gear and optical landing systems both shorebased and shipboard. ARBs are prepared by the Naval Air Warfare Center (NAWC), Lakehurst, NJ and issued by the Naval Air Systems Command (NAVAIRSYSCOM), Washington, DC. Data is obtained from shorebased and shipboard instrumented tests and approved by NAVAIRSYSCOM.

31.2 PURPOSE

ARBs DO NOT authorize the recovery of aircraft, but set forth the minimum conditions which must exist prior to the recovery of aircraft. Authority for recovery operations and other restrictions are contained in applicable NATOPS manuals.

31.3 ARB NUMBERING SYSTEM

ARB numbers consist of a two-digit designator followed by a two-digit dash number. All bulletins pertaining to the same equipment will bear the same designator number preceding the dash. The number following the dash identifies the subject content of the bulletin.

31.3.1 Designator Groups. ARBs cover two broad groups of equipment: arresting gear and optical landing aid systems. These groups are further divided into shipboard and shorebased systems. A third group of bulletins are general bulletins. The following designator numbers and categories are assigned:

Designator	Bulletin Category
10 to 19	General
20 to 39	Shipboard arresting gear
40 to 59	Shore based arr. gear
60 to 79	Shipboard landing aid systems
80 to 99	Shorebased landing aid systems

31.3.2 Dash numbers. ARBs are assigned DASH numbers to identify contents. Dash numbers are assigned as follows:

Dash No.	Subject Content of Bulletin
-10	General information concerning aircraft recovery
-11	Status of aircraft recovery bulletins
-12	Operating instructions and limits concerning recovery of aircraft
-13	Tabulation of aircraft recovery data

31.4 REVISION OF ARBs

ARBs are revised to reflect changes in aircraft or recovery equipment performance and the instructions concerning their operational use. Bulletins are updated by revision or amendment.

31.4.1 Bulletin Revision. A revision consists of a re-issue of the bulletin as a complete replacement for the previous issue and all associated amendments. Revisions are issued as required, and are identified by a letter following the bulletin number and a new date corresponding to the date of the revision.

31.4.2 Bulletin Amendment. An amendment is an addition or correction to an existing bulletin issued as a rapid and simple means of promulgating changes to current operating instructions. Amendments are identified by an amendment number and date, and may be issued as a Naval message in cases requiring immediate dissemination, or as a printed amendment (printed on green paper for identification).

31.5 COMMONLY-USED ARBs, CONTENT, AND APPLICATION

31.5.1 ARB 0-ll Actually an Aircraft Launching/Recovery Bulletin, issued quarterly to provide current status of all ARBs and ALBs (launching bulletins). It delineates current revision and applicable amendments for all ARBs and ALBs, and provides general information on ordering technical directives.

31.5.2 ARB 10-10 A general information bulletin setting forth the preparation, assumptions, and use of ARBs. It contains a great deal of information which is important for LSOs to understand in recovering aircraft, including:

- Definitions of terms such as recovery headwind (RHW), glideslope angle (basic angle), hook-to-eye, hook-to-ramp, etc.
- Source of information used in ARBs such as recommended glideslope settings, derivation of H/E values, minimum H/R clearances, approach airspeeds and angle of attack, aircraft landing weights, aircraft strength limits (hook load, horizontal drag load, sink speed), arresting gear performance, engaging speed limits, etc.
- Use of the -12 and -13 bulletins for arresting gear; application of single weight settings, and actual weight settings.
- Operational considerations for wind conditions including the "burble", recovery crosswind limits, optimum wind over deck, effective glidepath due to wind, engaging speed limits, and emergency (barricade) recovery.
- Landbased recovery operations for short-field, long-field, and aborted takeoff arrestments.

Additionally, sections of ARB 10-10 contain useful information suitable for all aircrews to read/understand regarding recovery operations.

31.5.3 ARB 29-12 Contains the governing instructions for recovery of aircraft with the Mk 7 Mod 3 arresting gear with operable sheave dampers. The Mk 7 Mod 2 arresting gear uses information contained in ARB 29-12.

These bulletins are intended for use when operating under ordinary conditions - normal day-to-day operations. The data is predicated on setting the arresting gear control valve for the single-weight setting of each aircraft. Maximum engaging speeds specified in these bulletins are for relatively large weight ranges; the maximum engaging speeds listed correspond to the most critical, i.e. heaviest, weight within each range. The letters after the engaging speed refer to bulletin notes indicating the strength factor (e.g., arresting hook, aircraft horizontal load, aircraft landing gear, arresting gear capacity) which limits the engaging speed.

Figure 31-1 is an excerpt from Figure 1 of ARB 29-12. As an example, for the EA-6B, takeoff flaps/slats extended (normal landing configuration), two weight ranges are listed in Column 2. The recommended approach airspeed (a calibrated airspeed) listed in Column 3 applies to the heaviest weight in each range. For deck pendant operations, the maximum engaging speeds and corresponding minimum recovery headwinds (RHW) for glideslope angles of 4.0 and 3.5 degrees are listed in Columns 4/5 and Columns 6/7, respectively. The limiting factor for a 4.0 degree glideslope is denoted by note "C", which corresponds to aircraft landing gear strength (the explanations for all notes are in the back of the ARB). All data is based upon use of the EA-6B single-weight setting of 46,000 pounds.

Column 8 is used for barricade recoveries only. It lists the barricade maximum engaging speed and aircraft gross weight. The minimum RHW for the barricade may be determined by subtracting the maximum engaging speed in Column 8 from the aircraft approach speed for the barricade. Note that this wind requirement for the barricade may, in some cases, differ from that required for the aircraft to recover safely (within arresting gear and aircraft structural limits) on the 4.0 degree glideslope used for the barricade. This is due to the fact that the barricade data in Column 8 only considers the physical capacity of the barricade itself to safely arrest an aircraft, irrespective of the limitations of the arresting gear (if used) or aircraft due to the 4 degree glideslope. In most cases the barricade RHW required will be more restrictive. The F/A-18 is one notable exception. Additionally, the barricade limits in Column 8 apply to **both** Mk 7 Mod 3 and Mk 7 Mod 2 arresting gear used as barricade engines on some ships.

The use of single-weight settings may, in some cases, actually impose a separate limitation on aircraft recovery that is more restrictive than limitations imposed by aircraft or arresting gear strength. This is noted in Columns 4 or 6, if applicable, as note "L" (see EA-6B, 30-degree flaps/slats extended, 3.5 degree glideslope in Figure 31-1). This control valve single-weight setting limitation results from a light-weight aircraft engaging an arresting gear set at a heavy control valve setting, thereby increasing the "g" load.

Figure 31-2 is an excerpt from Figure 2 of ARB 29-12, which lists recovery data for aircraft with abnormal landing configurations. For determining the RHW required for an abnormal landing configuration which is not listed in Figure 2 of the ARB, take the difference in approach speeds between the abnormal landing configuration and the normal landing configuration (of Figure 1) and add it to the RHW requirement listed in Figure 1 of the ARB.

Figure 31-3 is a representation of Table 1 of ARB 29-12, delineating the arresting gear control valve single-weight settings for all aircraft. Note that all single-weight settings are in whole thousand-pound increments and may be higher than the maximum aircraft landing weight (e.g., EA-6B max gross landing weight is 45,500 pounds; single-weight setting is 46,000 pounds).

An important note about all RHWs listed in the ARBs - they are based on standard day conditions (59°F temperature). For each 15-degree increase above 59°F, RHWs should be increased by 2 knots to compensate for the increase in aircraft approach speeds.

31.5.4 ARB 29-13. This bulletin contains the complete tabulation of recovery data for the Mk 7 Mod 3 arresting gear with operable sheave dampers. Similar information for the Mk 7 Mod 2 gear is provided in ARB 26-13.

The dash 13 bulletins provide the basic criteria from which the dash 12 bulletins are derived. Dash 13 bulletins may be used for any operating condition, and are usually referred to in extraordinary operating circumstances such as marginal or less than minimum wind conditions, or for certain aircraft emergencies when wind required becomes a problem under dash 12 bulletin criteria. The dash 12 bulletins have been generated from the dash 13 bulletins to simplify operations.

Engaging speed limits (aircraft and arresting gear) are printed separately in tabular form in the dash 13 bulletins. Individual tables are provided for each aircraft model, and include both normal and abnormal landing configurations. Additional tables are incorporated in cases where an aircraft service change has increased aircraft strength values or maximum landing weight.

Figure 31-4 is an example of one table from the 29-13 bulletin for the F-14A in its normal landing configuration. Column 1 lists all gross weights for the aircraft up the maximum arresting weight, in 500-pound increments. Additional intermediate weights may be included. For each gross weight specified, the recommended approach airspeed is given in Column 2. Columns 3 and 4 specify aircraft engaging speeds that produce limiting hook loads and maximum "g", respectively. Columns 5 and 6 specify the maximum permissible engaging speeds based on landing gear strength when operating with 4.0 and 3.5 degree glideslopes respectively. Column 7 lists the maximum permissible engaging speed based on arresting gear capacity.

Overload of the associated component may occur where any of the specified engaging speeds is exceeded. The most restrictive speed specified in Columns 3 through 7 is listed in Columns 8 and 10 for the 4.0 and 3.5 degree glideslopes, respectively. These represent the maximum permissible engaging speeds at which the aircraft and arresting gear have adequate strength in all respects when the control valve is set to the **actual aircraft gross landing weight.**

For the F-14A in Figure 31-4, a 52,000 pound aircraft requires 11 knots RHW on a 3.5 degree glideslope with the arresting gear control valve set for the 52,000 pound actual aircraft weight. This represents a max engaging speed of 122 knots, limited by hook loading (Column 3). On the other hand, a 52,000 pound F-14A recovering with the single-weight setting of 54,000 pounds set in the control valve requires 17 knots RHW on a 3.5 degree glideslope (ARB 29-12; see Figure 31-5). The difference of 6 knots RHW represents the benefit of using actual aircraft weight in the control valve setting. A 50,000 pound F-14A requires only 5 knots RHW on a 3.5 degree glideslope with actual weight set, limited by a max engaging speed of 125 knots due, once again, to hook load. If the single-weight setting (54,000 pounds) is used, however, 13 knots RHW are required limited by the fact that the control valve is set for the single-weight (note "L", ARB 29-12; See Figure 31-5).

Figure 31-6 is an example of an abnormal landing configuration table in ARB 29-13, for the E-2C with no flaps. "Dumping down" the aircraft to a 41,000 pound gross weight and setting this actual weight in the control valve reduces the RHW requirement from 47 knots on a 3.5 degree glideslope with the single weight setting of 45,000 pounds used (ARB 29-12; see Figure 31-7), to 35 knots- a considerable reduction, particularly if we're working with a conventional CV which may have difficulty making that much wind. The advantage of using ARB 29-13 when minimum wind becomes a problem is obvious.

31.5.5 ARB 12-12. This bulletin pertains to barricade engagement only. It contains information for deck pendant removal for various landing gear configurations during shipboard barricade recovery of aircraft. Pendant removal is a function of aircraft type and the landing gear configuration. Removal of pendants may help to prevent an aircraft from entering the barricade in an abnormal attitude or yaw. Barricade engagements for aircraft without gear malfunctions; e.g., low fuel state, should be made with all pendants in place and tailhook extended. Maximum off-center engagement is 8 feet for all aircraft except the E-2/C-2, which have a maximum off-center restriction of 2.5 feet.

Figure 31-8 is a representation of Table 1 of ARB 12-12. Notes "A" and "B" dictate removal or retention of all pendants for the landing gear configurations during and aircraft listed. Note "C" pertains only to launch bar down (unretracted) malfunctions, dictating which pendants should be removed if a normal arrestment is desired. If a barricade is preferred for a launch bar malfunction, all pendants should be removed.

ARB 12-12 shall not be used as the basis for a decision to barricade an aircraft; that decision should be based on NATOPS.

31.5.6 ARB 62-12. This bulletin contains information for recovery of aircraft using the Mk 6 Mod 3 Fresnel Lens Optical Landing System (FLOLS) and the Carrier Landing Aid Stabilization System (CLASS). It provides a physical description of the lens system, optical coverage, stabilization system and modes/limits, and operating instructions. It delineates minimum H/R requirements (10 feet for pendant engagements and 8 feet for barricade). Procedures for setting appropriate lens settings (hook path, hook-to-eye) for pendant/barricade recoveries, normal/ abnormal landing configurations, and the conditions under which the lens setting data has been calculated, and described.

Figure 31-9 is a representation of Table 2 of ARB 62-12, Fresnel lens setting factors. Data includes commanded H/R and HTDP for basic angles of 3.0, 3.5, 3.75 and 4.0 degrees for all aircraft carriers, as well as deck pendant locations.

Figures 31-10 and 31-11 are representations of Tables 3 and 4 of ARB 62-12, delineating Hook-to-eye (H/E) values for aircraft in normal and abnormal landing configurations.

Figures 31-12 and 31-13 are representations of Tables 31 and 32 of ARB 62-12, barricade engagement FLOLS parameters on CVN-71 for normal and abnormal landing configurations. Tables such as these are provided for each aircraft carrier in the ARB. Data includes H/E, barricade H/R clearance on the 4.0 degree glideslope, barricade hook touchdown point, and eye height above deck at the barricade position for all aircraft. An asterisk (*) next to the eye height value in Column 5 indicates that the aircraft will be in a 3-point attitude at the barricade; no asterisk indicates that the aircraft's nosewheel will **not** be on deck at the barricade position, a factor which the LSO must definitely consider (usually pertains to large H/E aircraft on the smaller CVs).

31.6 MISCELLANEOUS ARBs

Some additional ARBs which may need to be consulted for specific information include:

- ARB 45-12: M-21 Shorebased Arresting Gear (Marine Corps Expeditionary Gear)
- ARB 46-12: E-28 Shorebased Arresting Gear
- ARB 80-12: Mk 8 Mod O FLOLS

AIRCRAFT ENGAGING SPEED LIMITS FOR MARK 7 MOD 3 ARRESTING GEAR 115- TO 125- FOOT SPAN WITH OPERATING DECK SHEAVE DAMPERS

TYPE OF ARRESTMENT			DECK PENDANT				BARRICADE
GLIDE SLOPE SETTING			4.0 DEGREES		3.5 DEGREES		
AIRCRAFT MODEL	ACTUAL AIRCRAFT LANDING WEIGHT (POUNDS)	RECOMMENDED APPROACH AIRSPEED (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMME-NDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMME-NDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM PERMISSIBLE ENGAGING SPEED AND AIRCRAFT GROSS WEIGHT
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
TA-4F/J	Up to 15,000	131	130(A,B)	1	130(A,B)	1	105 Knots up to 14,500 Lb
A-6E 20-Degree Flaps, Slats Extended (II)	Up to 33,500 33,600-36,000 36,100-37,000 37,100-38,000	123(F) 128(F) 136(F,H) 138(F,H)	104(C) 104(C) 101(C) 99(C)	19 24 35 39	109(C) 109(C) 106(C) 104(C)	14 19 30 34	105 Knots up to 36,000 Lb
A-6E 30-Degree Flaps, Slats Extended	Up to 33,500 33,600-36,000 36,100-37,000 37,100-38,000	117(F) 122(F) 130(F,H) 132(F,H)	104(C) 104(C) 101(C) 99(C)	13 18 29 33	109(C) 109(C) 106(C) 104(C)	8 13 24 28	105 Knots up to 36,000 Lb
EA-6B 30-Degree Flaps, Slats Extended	Up to 45,500	129(F)	126(C)	3	128(L)	1	110 Knots up to 45,500 Lb
C-2A (REPROCURED) 30-Degree Flaps, 20 Units AOA	46,000-49,000 (G, EE)	103(H)	103(A)	0	103(A)	0	(S)
C-2A (REPROCURED) 20-Degree Flaps, 20 Units AOA	Up to 46,000 46,100-49,000 (EE)	106(H) 109(H)	95(L) 103(A)	25(V) 25(V)	95(L) 103(A)	25(V) 25(V)	(S)
E-2C 30-Degree Flaps, 20 Units AOA	Up to 45,000	105	84(L)	21	84(L)	21	(S)
E-2C(PLUS) 30-Degree Flaps, 20 Units AOA	Up to 46,500	115(H)	97(A)	18	97(A)	18	(S)
E-2C(PLUS) 20-Degree Flaps, 20 Units AOA	Up to 46,500	120(H)	97(A)	23	97(A)	23	(S)

Figure 31-1 ARB 29-12, FIGURE 1 (*Excerpt*) (NORMAL LANDING CONFIGURATION)

ABNORMAL LANDING CONFIGURATION

AIRCRAFT ENGAGING SPEED LIMITS FOR MARK 7 MOD 3 ARRESTING GEAR 115- TO 125- FOOT SPAN WITH OPERATING DECK SHEAVE DAMPERS

TYPE OF ARRESTMENT			DECK PENDANT				BARRICADE
GLIDE SLOPE SETTING			4.0 DEGREES		3.5 DEGREES		
AIRCRAFT MODEL	ACTUAL AIRCRAFT LANDING WEIGHT (POUNDS)	RECOMMENDED APPROACH AIRSPEED (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMME-NDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMME-NDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM PERMISSIBLE ENGAGING SPEED AND AIRCRAFT GROSS WEIGHT
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
A-6E, 30-Degree Flaps, No Slats	Up to 33,500 33,600-36,000	121 126	104(C) 104(C)	17 22	109(C) 109(C)	12 17	105 Knots up to 36,000 Lb
A-6E, No Flaps, No Slats	Up to 30,500 30,600-35,000	144 154	104(C) 104(C)	40 50	109(C) 109(C)	35 45	105 Knots up to 36,000 Lb
A-6E, No Flaps, Slats Extended	Up to 32,000 32,100-36,000	139 148	104(C) 104(C)	35 44	109(C) 109(C)	30 39	105 Knots up to 36,000 Lb
A-6E, 30-Degree Flaps, Slats Extended 800 lb or more on station 1 or 5	Up to 33,500 33,600-35,500	117(F) 121(F)	104(C) 88(C)	13 33	109(C) 93(C)	8 28	105 Knots up to 35,000 Lb
EA-6B, 30-Degree Flaps, No Slats	Up to 45,500	143	126(C)	17	128(L)	15	110 Knots up to 45,500 Lb
EA-6B, Single Engine 20-Degree Flaps 15 Units AOA	Up to 45,500	144	126(C)	18	128(L)	16	110 Knots up to 45,500 Lb
EA-6B, No Flaps, Slats Extended	Up to 38,000 38,100-43,000	169 178	128(L) 128(L)	41 50	128(L) 128(L)	41 50	110 Knots up to 45,500 Lb
EA-6B, No Flaps, No Slats	Up to 38,000 38,100-45,500	162 176	128(L) 126(C)	34 50	128(L) 128(L)	34 48	110 Knots up to 45,500 Lb
C-2A (REPROCURED) 10-Degree Flaps 21 Units AOA	Up to 41,000 41,100-49,000	108(H) 118(H)	95(L) 103(A)	25(V) 25(V)	95(L) 103(A)	25(V) 25(V)	(S)

Figure 31-2 ARB 29-12, FIGURE 2 (*Excerpt*) (ABNORMAL LANDING CONFIGURATION)

TABLE 1

ARRESTING GEAR CONTROL VALVE SINGLE-WEIGHT SETTING

AIRCRAFT MODEL	ARRESTING ENGINE CONTROL VALVE WEIGHT SETTING (POUNDS)
COLUMN 1	COLUMN 2
TA-4F/J	15,000
A-6E	38,000
EA-6B	46,000
C-2A(REPROCURED)	49,000
E-2C, E-2C(PLUS)	47,000
F-14A	54,000
F-14B/D RATS ON	54,000
F-14B/D RATS OFF	58,000
F/A-18A/B/C/D	36,000
S-3 SERIES	41,000
T-2B/C	12,000
T-45A	12,000

Figure 29-12, TABLE 1 (ARRESTING GEAR CONTROL VALVE SINGLE WEIGHT SETTING)

TABLE 27

F-14A

H.L. LB	MAX. G	SINK SPD AT LIMIT FT/SEC	WT-LB
165000	3.15	25.3	51800

20 DEGREE WING SWEEP, FLAPS/SLATS EXTENDED,
AUXILIARY FLAPS EXTENDED, DLC ENGAGED, 15 UNITS AOA

ACFT SERVICE CHANGES REQUIRED
735/AVC 3005

ACFT GR WT LB	REC APP SPD	MAX. VEL H.L.	MAX. VEL G	MAX.VEL L.G. 4.0 DEG	MAX.VEL L.G. 3.5 DEG	MAX.VEL A.G. CAPY	4.0 DEG MAX. VEL	4.0 DEG MIN RHW	3.5 DEG MAX. VEL	3.5 DEG MIN RHW
COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10	COL 11
42000	120	141	134	144	149	141	134	-14	134	-14
42500	120	140	134	144	149	140	134	-14	134	-14
43000	121	139	134	144	149	139	134	-13	134	-13
43500	122	137	134	144	149	139	134	-12	134	-12
44000	123	136	134	144	149	138	134	-11	134	-11
44500	123	135	134	144	149	137	134	-11	134	-11
45000	124	134	134	144	149	136	134	-10	134	-10
45500	125	133	133	144	149	136	133	-8	133	-8
46000	126	132	133	144	149	135	132	-6	132	-6
46500	126	131	133	144	149	134	131	-5	131	-5
47000	127	131	133	144	149	133	131	-4	131	-4
47500	128	130	133	144	149	132	130	-2	130	-2
48000	129	129	133	144	149	132	129	0	129	0
48500	129	128	133	144	149	131	128	1	128	1
49000	130	127	133	144	149	130	127	3	127	3
49500	131	126	132	144	149	129	126	5	126	5
50000	132	125	132	144	149	129	125	7	125	7
50500	132	124	132	144	149	128	124	8	124	8
51000	133	124	132	144	149	127	124	9	124	9
51500	134	123	132	144	149	126	123	11	123	11
51800	134	122	132	144	149	126	122	12	122	12
52000	135	122	132	144	149	126	122	13	122	13
52500	135	121	132	143	148	125	121	14	121	14
53000	136	120	132	142	147	125	120	16	120	16
53500	137	120	132	141	146	124	120	17	120	17
54000	138	119	132	140	145	123	119	19	119	19

SINGLE WEIGHT SETTING	WEIGHT RANGE	SINGLE WEIGHT SETTING LIMIT
54000	42000 - 46000	114
54000	46100 - 51800	119
54000	51900 - 54000	119

Figure 31-4 ARB 29-13, TABLE 27 (F-14A, NORMAL LANDING CONFIGURATION)

FOR TRAINING USE ONLY

AIRCRAFT ENGAGING SPEED LIMITS FOR MARK 7 MOD 3 ARRESTING GEAR 115- TO 125- FOOT SPAN WITH OPERATING DECK SHEAVE DAMPERS

TYPE OF ARRESTMENT			DECK PENDANT				BARRICADE
GLIDE SLOPE SETTING			4.0 DEGREES		3.5 DEGREES		
AIRCRAFT MODEL	ACTUAL AIRCRAFT LANDING WEIGHT (POUNDS)	RECOMMENDED APPROACH AIRSPEED (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMME-NDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMME-NDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM PERMISSIBLE ENGAGING SPEED AND AIRCRAFT GROSS WEIGHT
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
F-14A, 20-Degree Wing Sweep, Flaps & Slats Extended, Auxiliary Flaps Extended, DLC Engaged, 15 Units AOA	Up to 46,000 46,100-51,800 51,900-54,000	126(T) 134(T) 138(T)	114(L) 119(L) 119(A)	12 15 19	114(L) 119(L) 119(A)	12 15 19	108 Knots up to 51,800 Lb
F-14B/D RATS ON 20-Degree Wing Sweep, Flaps & Slats Extended Auxiliary Flaps Extended, DLC Engaged, 15 Units AOA	Up to 46,000 46,100-52,000 52,100-54,000	131(T,H) 140(T,H) 143(T,H)	114(L) 119(L) 119(A)	17 21 24	114(L) 119(L) 119(A)	17 21 24	108 Knots up to 51,800 Lb
F/A-18 A/B/C/D Full Flaps with AFC 029 F404-GE-400 or F404-GE-402 engine (CC,R)	Up to 33,000 (CC) 33,100-34,000	146(H) 148(H)	130(L) (R)	16 (R)	130(L) 130(A)	16 18	135 Knots up to 33,000 Lb (X,Y,Z)
S-3A/B, ES-3A with ECP 347, Landing Flaps (W)	Up to 40,500	116	115(C)	1	119(L)	-3	110 Knots up to 37,700 Lb
S-3A/B, ES-3A with ECP 347, Takeoff Flaps (W)	Up to 40,500	125	115(C)	10	119(L)	6	110 Knots up to 37,700 Lb
KS-3A with ECP 347, Landing Flaps (W)	Up to 37,700	112	108(L)	4	108(L)	4	110 Knots up to 37,700 Lb

Figure 31-5 ARB29-12, FIGURE 1 (*Excerpt*) (NORMAL LANDING CONFIGURATIONS)

FOR TRAINING USE ONLY

TABLE 20

E-2C

H.L. LB	MAX. G	SINK SPD AT LIMIT FT/SEC	WT-LB
85400	2.10	20.8	40660

NO FLAPS 22 UNITS AOA

ACFT SERVICE CHANGES REQUIRED
0 0 0 0 0 0

ACFT GR WT LB	REC APP SPD	MAX. VEL H.L.	MAX. VEL G	MAX.VEL L.G. 4.0 DEG	MAX.VEL L.G. 3.5 DEG	MAX.VEL A.G. CAPY	4.0 DEG MAX. VEL	4.0 DEG MIN RHW	3.5 DEG MAX. VEL	3.5 DEG MIN RHW
COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10	COL 11
37000	121	99	106	106	111	145	99	22	99	22
37500	121	98	106	106	111	145	98	23	98	23
38000	122	97	106	106	111	145	97	25	97	25
38500	123	96	106	106	111	145	96	27	96	27
39000	124	95	106	106	111	145	95	29	95	29
39500	125	94	105	106	111	145	94	31	94	31
40000	125	94	105	106	111	145	94	31	94	31
40500	126	93	105	106	111	144	93	33	93	33
41000	127	92	105	105	110	143	92	35	92	35
41200	127	92	105	105	110	142	92	35	92	35
41500	128	91	105	104	109	142	91	37	91	37
42000	128	91	105	103	108	141	91	37	91	37
42500	129	90	105	102	107	140	90	39	90	39
43000	130	89	104	101	106	139	89	41	89	41
43500	131	88	104	100	105	139	88	43	88	43
44000	132	88	104	99	104	138	88	44	88	44
44500	132	87	104	98	103	137	87	45	87	45
45000	133	86	104	97	102	137	86	47	86	47

SINGLE WEIGHT SETTING	WEIGHT RANGE	SINGLE WEIGHT SETTING LIMIT
47000	37000 - 40000	84
47000	40100 - 45000	84

Figure 31-6 ARB 29-13, TABLE 20 (E-2C, NO FLAPS)

AIRCRAFT RECOVERY BULLETIN NO. 29-12Z NAVAIRWARCENACDIVLKE-48J400B

ABNORMAL LANDING CONFIGURATION

AIRCRAFT ENGAGING SPEED LIMITS FOR MARK 7 MOD 3 ARRESTING GEAR 115- TO 125- FOOT SPAN WITH OPERATING DECK SHEAVE DAMPERS

TYPE OF ARRESTMENT			DECK PENDANT				BARRICADE
GLIDE SLOPE SETTING			4.0 DEGREES		3.5 DEGREES		
AIRCRAFT MODEL	ACTUAL AIRCRAFT LANDING WEIGHT (POUNDS)	RECOMMENDED APPROACH AIRSPEED (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMMENDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM RHW RECOMMENDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM PERMISSIBLE ENGAGING SPEED AND AIRCRAFT GROSS WEIGHT
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
C-2A (REPROCURED) No Flaps 22 Units AOA	Up to 41,000 41,100-49,000	115(H) 126(H)	95(L) 103(A)	25(V) 25(V)	95(L) 103(A)	25(V) 25(V)	(S,J)
E-2C, 20-Degree Flaps 20 Units AOA	Up to 45,000	111	84(L)	27	84(L)	27	(S)
E-2C, 10-Degree Flaps 21 Units AOA (K)	Up to 40,000 40,100-45,000	112 119	84(L) 84(L)	28 35	84(L) 84(L)	28 35	(S,J)
E-2C, No Flaps 22 Units AOA (K)	Up to 40,000 40,100-45,000	125 133	84(L) 84(L)	41 49	84(L) 84(L)	41 49	(S,J)
E-2C(PLUS), 10-Degree Flaps 22 Units AOA	Up to 46,500	124(H)	97(A)	27	97(A)	27	(S,J)
E-2C(PLUS) No Flaps 24 Units AOA	Up to 46,500	131(H)	97(A)	34	97(A)	34	(S,J)
F-14A, 20-Degree Wing Sweep, Flaps & Slats Extended, Auxiliary Flaps Retracted, DLC Disengaged, 15 Units AOA	Up to 46,000 46,100-51,800 51,900-54,000	124 132 136	114(L) 119(L) 119(A)	10 13 17	114(L) 119(L) 119(A)	10 13 17	108 Knots up to 51,800 Lb

Figure 31-7 ARB 29-12, FIGURE 2 (*Excerpt*) (ABNORMAL LANDING CONFIGURATIONS)

IV-31-13

AIRCRAFT RECOVERY BULLETIN NO 12-12F **NAVAIRWARCENACDIVLKE-IS14**

TABLE 1

PENDANT CONFIGURATIONS FOR BARRICADE RECOVERY OF AIRCRAFT WITH MALFUNCTIONING OR DAMAGED LANDING GEAR

	AIRCRAFT MODEL				
FINAL LANDING GEAR CONFIGURATION	EA-6B	C-2 E-2	F-14	F-18	S-3
1. Nose gear retracted or trailing	B	B	A	A	B
2. One main gear retracted or trailing (See Notes 1 and 2)	B	B	B	B	B
3. Stub nose gear	B	B	A	A	B
4. One or both main gear retracted or Acocked@ (See Note 3)	A	A	A	A	A
5. Nose gear and one main gear retracted or trailing	B	B	A	A	B
6. Both main gear retraced or trailing	B	B	B	B	B
7. All gear up	B	B	B	B	B
8. Launch bar in DOWN position (unretracted)	C	C	C	C	C

A = REMOVE ALL PENDANTS **WARNING** APPLICABLE

B = LEAVE ALL PENDANTS

C = IF THE LAUNCH BAR CANNOT BE RAISED AND THE AIRCRAFT CANNOT BE DIVERTED, NORMAL ARRESTMENT IS RECOMMENDED WITH PENDANTS 1 AND 4 REMOVED FOR F-14 AND F-18 AIRCRAFT, AND PENDANTS 3 AND 4 REMOVED FOR ALL OTHER NOSE GEAR LAUNCHED AIRCRAFT.

WARNING

THE PILOT AND CONTROLLING LSO MUST TAKE EVERY EFFORT TO ENSURE THAT THE NOSEWHEEL DOES NOT TOUCHDOWN SHORT (AFT) OF ANY ARRESTING WIRE.

SHOULD A NORMAL ARRESTMENT BE CONSIDERED IMPRACTICAL OR UNDESIRABLE, HOWEVER, AND A BARRICADE RECOVERY IS PREFERRED, ALL PENDANTS SHOULD BE REMOVED.

NOTES:
1. Includes F-14 side braces not in place.
2. Includes F-18 cocked main landing gear (planing link failure).
3. Includes F-14 main gear hyperextensions.

Figure 31-8 ARB 12-12, TABLE 1 (EXCERPT) (PENDANT CONFIGURATIONS FOR BARRICADE RECOVERY OF AIRCRAFT)

FOR TRAINING USE ONLY

AIRCRAFT RECOVERY BULLETIN N0. 62-12D NAVAIRWARCENACDIVLKE-4.8.10.4B

TABLE 2

FRESNEL LENS SETTING FACTORS
MARK 6 FRESNEL LENS OPTICAL LANDING SYSTEM

APPLICABLE SHIP	HOOK-TO-RAMP (FT) / HOOK-TOUCHDOWN POINT (FT) FOR BASIC ANGLE OF:				PENDANT LOCATIONS DISTANCE FROM RAMP (FT)			
	3.0 Degree (a)	3.5 Degree (a)	3.75 Degree (a)	4.0 Degree (a)	PENDANT 1	PENDANT 2	PENDANT 3	PENDANT 4
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9
CV 62	—	11.3/185	12.1/185	12.9/185	136.6	168.3	202.1	236.6
CV 63	12.3/234	14.3/234	15.3/234	16.4/234	173.8	213.7	255.2	297.2
CV 64	12.3/234	14.3/234	15.3/234	16.4/234	173.8	213.7	255.2	297.2
CVN 65	12.2/233	14.2/233	15.3/233	16.3/233	172.6	212.6	252.6	292.6
CV 66	12.3/234	14.3/234	15.3/234	16.4/234	173.9	213.9	253.9	299.6
CV 67	12.3/235	14.4/235	15.4/235	16.4/235	173.9	213.9	255.7	295.7
CVN 68	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2
CVN 69	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2
CVN 70	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2
CVN 71	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2
CVN 72	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2
CVN 73	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2
CVN 74	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2

(a) Information given in Column 2, 3, 4, and 5 is applicable for pendant arrestments only.

Figure 31-9 ARB 62-12, TABLE 2 (FRESNEL LENS SETTING FACTORS)

FOR TRAINING USE ONLY

AIRCRAFT RECOVERY BULLETIN N0. 62-12D NAVAIRWARCENACDIVLKE-4.8.10.4B

TABLE 3

HOOK-TO-EYE (H/E) VALUES FOR AIRCRAFT IN NORMAL LANDING CONFIGURATION

AIRCRAFT MODEL	AIRCRAFT H/E VALUE (FEET)
TA-4J	16.25
A-6E, 20° or 30° FLAPS / SLATS EXTENDED	16.75
EA-6B, 30 DEGREE FLAPS / SLATS EXTENDED	18.75
S-3A SERIES WITH ECP 347 (ALL CONFIGURATIONS)	14.50
C-2A, E-2 SERIES (FULL AND 20 DEGREE FLAPS); S-3A SERIES WITHOUT ECP 347 (ALL CONFIGURATIONS)	15.00
F-14A, F-14B/D	19.70
F/A-18A/B/C/D (ALL CONFIGURATIONS)	16.70
T-2B/C FORWARD COCKPIT	12.00
T-45A	12.00

Figure 31-10 ARB 62-12, TABLE 3 (HOOK-TO-EYE VALUES, NORMAL LANDING CONFIGURATION)

AIRCRAFT RECOVERY BULLETIN N0. 62-12D NAVAIRWARCENACDIVLKE-4.8.10.4B

TABLE 4

HOOK-TO-EYE (H/E) VALUES FOR AIRCRAFT IN ABNORMAL LANDING CONFIGURATION

AIRCRAFT MODEL	AIRCRAFT H/E VALUE (FEET)
A-6E 20° or 30° FLAPS / SINGLE ENGINE	16.75
A-6E 20° or 30° FLAPS / NO SLATS	15.50
A-6E NO FLAPS / NO SLATS	17.00
A-6E NO FLAPS / SLATS EXTENDED	17.50
EA-6B, 30 DEGREE FLAPS / NO SLATS	15.50
EA-6B, NO FLAPS / NO SLATS OR NO FLAPS / SLATS EXTENDED	16.50
EA-6B SINGLE ENGINE, 20 DEGREE FLAPS, 15 UNITS AOA	17.75
C-2A, 10 DEGREE FLAPS	16.00
C-2A, NO FLAPS	17.00
E-2 SERIES, 10 DEGREE FLAPS	17.40
E-2 SERIES, NO FLAPS	18.70
F-14A, F-14B/D SINGLE ENGINE OR NO FLAPS	19.00

Figure 31-11 ARB 62-12, TABLE 4 (HOOK-TO-EYE VALUES, ABNORMAL LANDING CONFIGURATION)

AIRCRAFT RECOVERY BULLETIN N0. 62-12D   NAVAIRWARCENACDIVLKE-4.8.10.4B

BARRICADE CVN 71 BARRICADE

TABLE 23

MARK 6 FLOLS PARAMETERS FOR BARRICADE ENGAGEMENTS NORMAL LANDING CONFIGURATION

AIRCRAFT MODEL	4.0 BASIC ANGLE SETTING			
	AIRCRAFT H/E VALUE (FEET)	HOOK-TO-RAMP CLEARANCE (FEET)	HOOK-TOUCHDOWN POINT FORWARD OF RAMP (FEET)	EYE HEIGHT ABOVE DECK AT BARRICADE POSITION (FEET)
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
TA-4J	16.25	10.4	149	10.0'
A-6E 20° or 30° FLAPS / SLATS EXTENDED	16.75	10.7	152	11.0'
EA-6B, 30-DEGREE FLAPS / SLATS EXTENDED	18.75	9.8	139	11.2'
C-2A, E-2 SERIES, (FULL AND 20 DEGREE FLAPS)	15.00	10.8	154	9.5'
F-14A, F-14B/D	19.70	9.1	130	10.8'
F/A-18A/B/C/D (ALL CONFIGURATIONS)	16.70	9.6	137	8.8'
S-3A SERIES WITHOUT ECP 347 (ALL CONFIGURATIONS)	15.00	10.6	151	9.1'
S-3A SERIES WITH ECP 347 (ALL CONFIGURATIONS)	14.50	10.9	155	9.1'

(a) Any value of H/E in column 2 above, which is not represented by a switch on the A210/A220 remote control panel, must be set by using the NON STD HOOK EYE DISTANCE controls and setting the HOOK-TO-EYE DISTANCE-FEET (AIRCRAFT TYPE) to NON STANDARD SETTING (see paragraph 9b).

(b) Theoretical hook-touchdown points listed in column 4 above must be used for barricade engagements. These values must be set by using the NON STD HOOK PATH STATIC COMMAND controls and setting the HOOK PATH COMMAND to NON STANDARD (see paragraph 9a(2)).

Figure 31-12 ARB 62-12, TABLE 23 (CVN-71 BARRICADE FLOLS PARAMETERS, NORMAL LANDING CONFIGURATION)

FOR TRAINING USE ONLY

BARRICADE CVN 71 BARRICADE

TABLE 24

MARK 6 FLOLS PARAMETERS FOR BARRICADE ENGAGEMENTS ABNORMAL LANDING CONFIGURATION

AIRCRAFT MODEL	4.0 BASIC ANGLE SETTING			
	AIRCRAFT H/E VALUE (FEET)	HOOK-TO-RAMP CLEARANCE (FEET)	HOOK-TOUCHDOWN POINT FORWARD OF RAMP (FEET)	EYE HEIGHT ABOVE DECK AT BARRICADE POSITION (FEET)
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
A-6E, 20° or 30° FLAPS / SINGLE ENGINE	16.75	10.7	152	11.0'
A-6E, 20° or 30° FLAPS / NO SLATS	15.50	11.3	161	11.0'
A-6E, NO FLAPS / NO SLATS	17.00	10.6	150	11.0'
A-6E, NO FLAPS / SLATS EXTENDED	17.50	10.3	147	11.0'
EA-6B, 30-DEGREE FLAPS / NO SLATS	15.50	11.4	163	11.2'
EA-6B, NO FLAPS / NO SLATS OR NO FLAPS / SLATS EXTENDED	16.50	10.9	155	11.2'
EA-6B, SINGLE ENGINE, 20-DEGREE FLAPS, 15 UNITS AOA	17.75	10.3	146	11.2'
C-2A, 10-DEGREE FLAPS	16.00	10.3	147	9.5'
C-2A, NO FLAPS	17.00	9.8	140	9.5'
E-2 SERIES, 10-DEGREE FLAPS	17.40	9.6	137	9.5'
E-2 SERIES, NO FLAPS	18.70	9.0	128	9.5'
F-14A, F-14B/D, SINGLE ENGINE OR NO FLAPS	19.00	9.5	135	10.8'

(a) Any value of H/E in column 2 above, which is not represented by a switch on the A210/A220 remote control panel, must be set by using the NON STD HOOK EYE DISTANCE controls and setting the HOOK-TO-EYE DISTANCE-FEET (AIRCRAFT TYPE) to NON STANDARD SETTING (see paragraph 9b).

(b) Theoretical hook-touchdown points listed in column 4 above must be used for barricade engagements. These values must be set by using the NON STD HOOK PATH STATIC COMMAND controls and setting the HOOK PATH COMMAND to NON STANDARD (see paragraph 9a(2)).

Figure 31-13 ARB 62-12, TABLE 24 (CVN-71 BARRICADE FLOLS PARAMETERS, ABNORMAL LANDING CONFIGURATION)

CHAPTER 32

AIRCRAFT LAUNCHING BULLETINS

32.1 GENERAL

Aircraft Launching Bulletins (ALBs) contain instructions for launching a specific aircraft from a specific catapult. They set forth uniform instructions for safely launching within the performance capabilities of the aircraft and catapults. An Aircraft Launching Bulletin DOES NOT authorize the launching of aircraft, but sets forth the minimum conditions which must exist prior to the launching of aircraft once such authorization is received. Authority to launch and other restrictions are contained in applicable NATOPS manuals.

32.2 PURPOSE

Authority to launch and other restrictions for launching aircraft are contained in applicable NATOPS flight manuals. Strict adherence to the provisions set forth are MANDATORY for safety of operations.

32.3 ALB DESIGNATORS

Types of ALBs are as follows:

1. General purpose ALBs for all aircraft and all catapults:

   a. 0-10 Bulletin - Provides general information and data on the preparation and use of all bulletins.

   b. 0-11 Bulletin - (An Aircraft Launching/ Recovery Bulletin) - Issued quarterly, provides a list of all bulletins currently in effect, canceled or superseded.

   c. 0-12 Bulletin - Provides a complete list of launching accessories required for all types of aircraft, foreign and domestic. It is a one time issue bulletin. Any changes to this bulletin will appear in the 0-11 Bulletin.

   d. 0-13 Bulletin - Provides a list of launching accessories for cross operations.

   e. 0-14 Bulletin - Provides data for the operation of steam catapults with reduced receiver volume.

   f. 0-15 Bulletin - Provides data for crosswind launches. Includes trim settings, excess endspeed requirements and a discussion of off-center spotting.

   g. 0-16 Bulletin - Go/no go information concerning physical restrictions that apply when launching from waist catapults.

2. General bulletins for launching specific aircraft:

0 - 37 And Subsequent Bulletins - Contain special instructions for launching specific aircraft, including launch precautions, corrections for minimum WOD, trim settings, off-center spotting limitations, etc. They are Aircraft Data Supplements for all catapults. EXAMPLE: 0-65 series bulletins pertain to F-14 aircraft.

3. Specific purpose ALB designators:

Designators for specific catapults on specified CVs (used in conjunction with suffixes described in 3.b. below to designate a bulletin applicable to a specific aircraft, on a specific catapult, on a specific CV):

BULLETIN SHIP (CATAPULT) SERIES
9- CV-63 (C13 catapult)
30- CV-64 (C13 catapult)
12- CVN-65 (C13 catapult)
19- CV-67 (C13 catapult)
20- CV-67 (C13-1 catapult)
22- CVN-68 (C13-1 catapult)
24- CVN-69 (C13-1 catapult)
27- CVN-70 (C13-1 catapult)
31- CVN-71 (C13-1 catapult)
32- CVN-72 (C13-2 catapult)
33- CVN-73 (C13-2 catapult)
34- CVN-74 (C13-2 catapult)
35- CVN-75 (C13-2 catapult)

Designators (suffixes) for specific aircraft:

-21 and subsequent - Provide special instructions for launching specified aircraft from specific catapults. EXAMPLE: ALB 20-65L provides data/information for launching F-14A aircraft on a C13-1 catapult on CV-67.

32.4 "Q" ALB. Another type of bulletin is the "Q" ALB. "Q" ALBs are classified and distributed on a "need-to-know" basis only. They are for wartime use only and authorize launching aircraft at higher gross weights and launch pressure or CSV settings than are currently permitted by NATOPS Flight Manuals and ALBs. Use of War Emergency Bulletins may cause the aircraft catapulting strength design limit to be exceeded by as much as 15 percent. An aircraft logbook entry is required if used.

CHAPTER 33

GLIDESLOPE GEOMETRY

33.1 GENERAL

As a Landing Signal Officer aboard today's aircraft carriers, a thorough understanding of glideslope geometry is essential for safe and expeditious recoveries, and to establish credibility in controlling aircraft. All of the following terms and relationships have been presented before at the U.S. Navy LSO School, this chapter is meant to be used by the LSO as a refresher prior to embarked operations.

33.2 DEFINITIONS

The following are definitions of some commonly used terms:

1. **Carrier Landing Aid Stabilization System (CLASS).** The Mk 6 Mod 3 Fresnel Lens Optical Landing System is currently used on all fleet aircraft carriers. The CLASS system has simplified the job of the LSO by alleviating the need to manually adjust roll angle to compensate for ship's static mistrim. CLASS incorporates a computer that automatically adjusts roll angle for any static mistrim condition in order to maintain a constant targeted (commanded) hook touchdown point (HTDP). In fact, the LSO has no means of manually selecting a roll angle with the CLASS system. CLASS uses three inputs along with static mistrim to set the proper lens roll angle. These three direct inputs are: 1) basic angle of the lens; 2) hook-to-eye value of each aircraft; and 3) commanded hook touchdown point (HTDP). Since roll angle cannot be manually input into the CLASS system, when the CLASS system malfunctions, rigging the MOVLAS is the only option available to the LSO until the malfunction is fixed.

2. **Basic Angle.** The pitch angle of the lens center cell measured with respect to the horizon. This selectable setting is one of the three inputs to the CLASS system, and is usually set at 3.50, 3.75, or 4.00 degrees.

3. **Lens Pitch Command.** The pitch angle of the lens center cell measured with respect to the carrier deck. This is the basic angle plus or minus ship's static mistrim. When the carrier deck is level; i.e., there is no static pitch or roll mistrim, the lens pitch command equals basic angle.

4. **Hook Touchdown Constant (HTDC).** Defined as 1/Tangent of the lens pitch command. Stated another way, HTDC is the amount of translation of the hook touchdown point (HTDP) forward or aft in the landing area for each one-foot deviation in hook-to-ramp (H/R) clearance. This value is a linear proportion, and is not dependent on specific ship or deck layout. Figure 33-1 depicts the change in HTDP ("y") as hook-to-ramp changes ("x").

33.3 BASIC GLIDESLOPE GEOMETRY RELATIONSHIPS

All of the relationships which comprise "glideslope geometry" really have to do with the simple relationships of right triangles. In Figure 33-2, a right triangle is formed from the hook-to-ramp (H/R) distance, the hook touchdown point, and the hook path. We refer to the hook path angle or glideslope angle as theta (Θ). With a level deck, theta equals the basic angle. When the deck is not level with the horizon, theta remains the angle between the theoretical hook path (or pilot's eye path, which is parallel to the hook path) and the deck. This angle is the lens pitch command.

In trigonometry, the Tangent of a right triangle equals the length of the opposite side divided by the length of the adjacent side (Figure 33-3). The opposite side is hook-to-ramp, and the adjacent side is hook touchdown point as measured from the ramp forward.

From this three useful formulas are derived:

1) $\tan \Theta = \frac{\text{hook-to-ramp}}{\text{hook touchdown point}}$

2) $\text{Hook touchdown point} = \frac{\text{hook-to-ramp}}{\tan \Theta}$

3) Hook-to-ramp = hook touchdown point X TAN Θ

Since most LSOs do not have a calculator with a Tangent function with them on the LSO platform, these equations are not really useful for quick figuring during recovery operations. Knowing that hook touchdown constant is defined as 1/TAN Θ, these formulas may be simplified as follows:

1) Hook touchdown constant = $\frac{\text{hook touchdown point}}{\text{hook-to-ramp}}$

or, HTDC = HTDP / H/R

2) Hook touchdown point = hook touchdown constant X hook-to-ramp

or, HTDP = HTDC X H/R

3) Hook-to-ramp = $\frac{\text{hook touchdown point}}{\text{hook touchdown constant}}$

or, H/R = HTDP/HTDC

Figure 33-4 provides a useful reference for platform operations based upon the above relationships and the fact that hook touchdown constants are the same for every aircraft carrier. This table includes minimum hook touchdown points for normal pendant operations and barricade situations. Aircraft Recovery Bulletin 10-10 states, "..steady deck hook-to-ramp shall be no less than 10 feet for deck pendant engagements and 8 feet for barricade engagements."

The tabulated minimum hook touchdown points were derived by simply multiplying the hook touchdown constant for a given lens pitch command by 10 feet for pendant recoveries and 8 feet for barricade recoveries.

33.4 AIRCRAFT RECOVERY BULLETIN 62-12

Aircraft Recovery Bulletin 62-12 provides a great deal of important information to the LSO. Table 2 of that ARB delineates optimum hook-to-ramp and hook touchdown point information for each aircraft carrier, as well as the location of each pendant in distance from the ramp. Figure 33-5 is a representative excerpt from that table.

Why is it that USS CONSTELLATION (CV-64) has more hook-to-ramp than USS NIMITZ (CV-68)? How are these hook-to-ramp values derived? These and other questions may be answered with basic glideslope geometry relationships and the data in this table.

When they decide where they want aircraft to optimally touchdown on a carrier, a hook touchdown point is chosen directly between the #2 and #3 crossdeck pendants. This point is 230 feet from the ramp on NIMITZ and 234 feet from the ramp on CONSTELLATION. Hook-to-ramp may then be derived by the formula:

H/R = HTDP/HTDC.

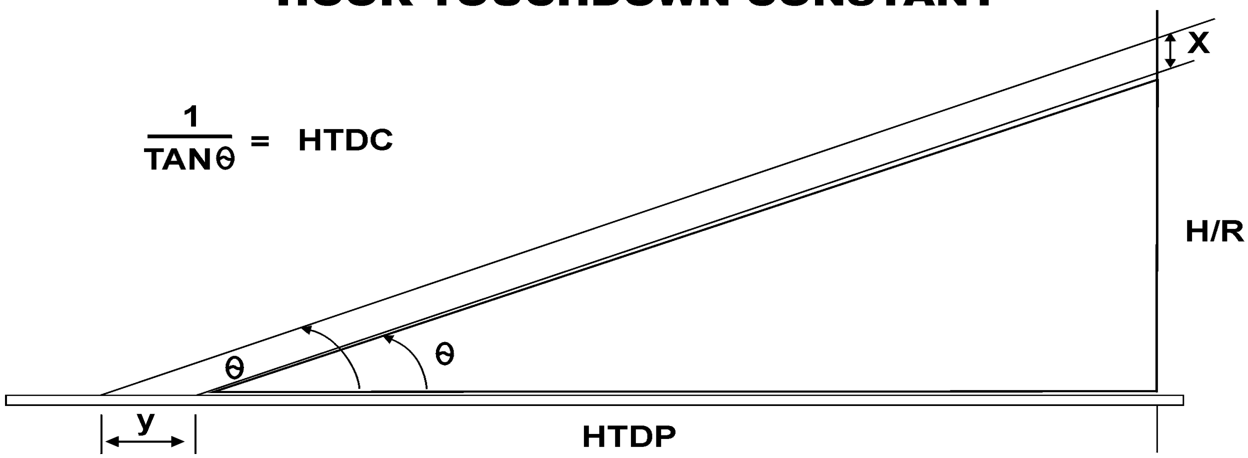
For NIMITZ, on a 4.0 degree glideslope (basic angle):

$\frac{\text{230 feet HTDP}}{\text{14.3 HTDC}}$ = 16.1 feet hook-to-ramp.

For CONSTELLATION, on a 4.0 degree glideslope (basic angle):

$\frac{\text{234 feet HTDP}}{\text{14.3 HTDC}}$

HOOK TOUCHDOWN CONSTANT



=
16.4 feet hook-to-ramp.

Figure 33-1 Hook Touchdown Constant

RIGHT TRIANGLE

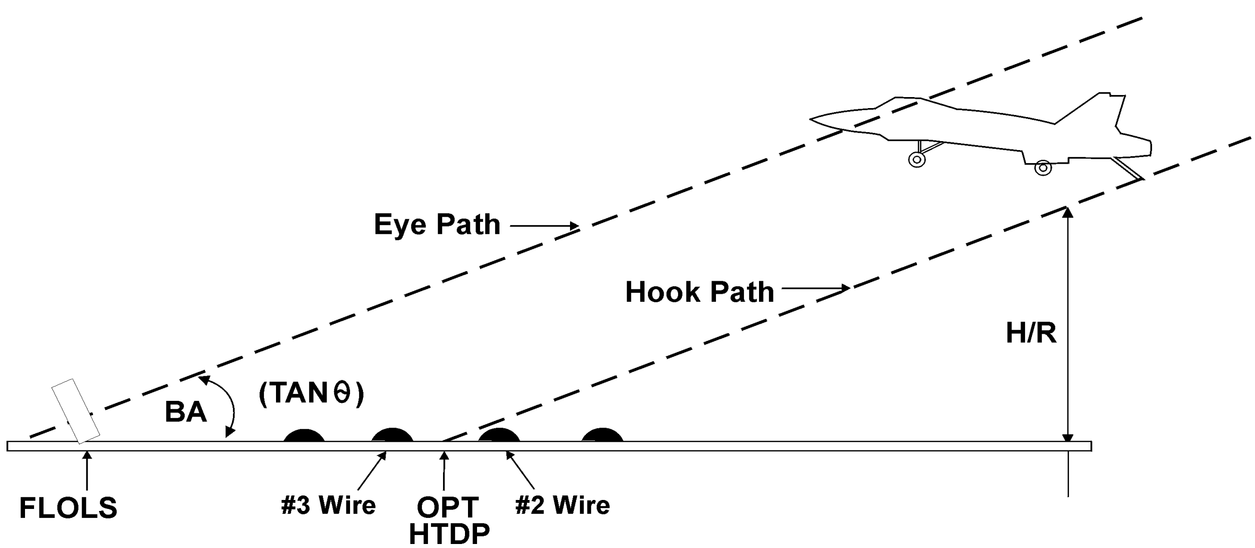


Figure 33-2 Glideslope Geometry Right Triangle

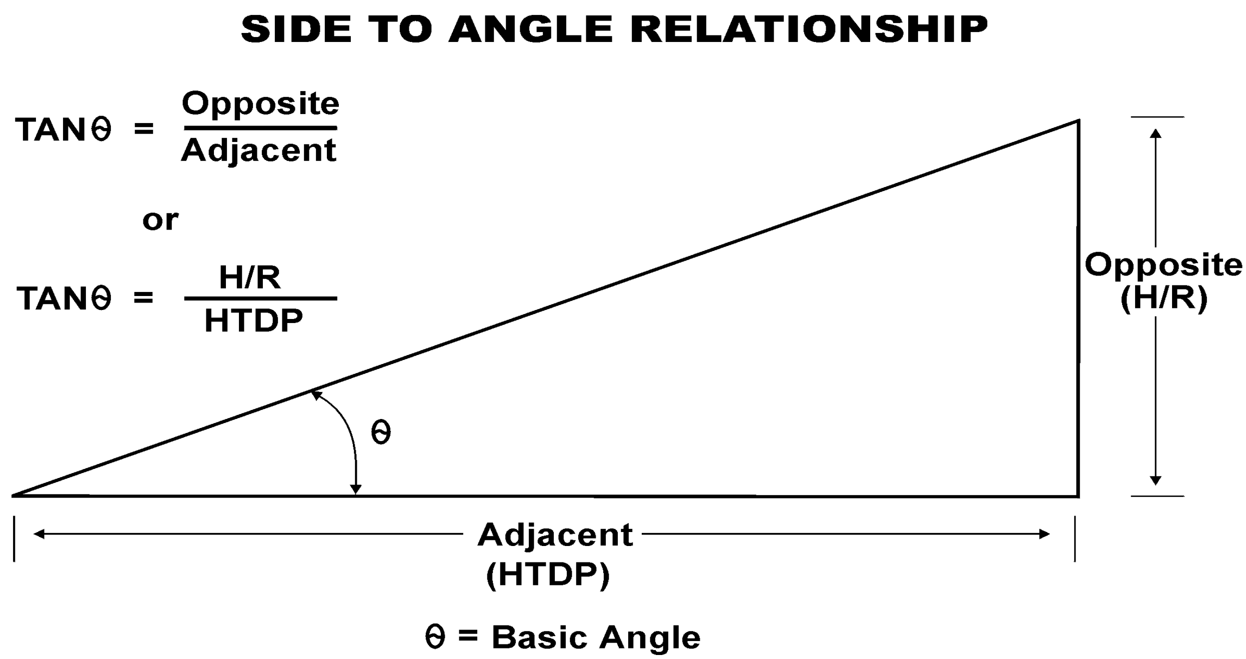


Figure 33-3 Right Triangle Relationships

LENS PITCH COMMAND	HOOK TOUCHDOWN CONSTANT	MINIMUM HTDP PENDANT OPS (10 Ft. H/R)	MINIMUM HTDP BARRICADE OPS (10 Ft. H/R)
2.50E	22.9	229 Ft.	ω
2.75E	20.8	208 Ft.	ω
3.00E	19.1	191 Ft.	153 Ft.
3.10E	18.5	185 Ft.	148 Ft.
3.20E	17.9	179 Ft.	143 Ft.
3.25E	17.6	176 Ft.	141 Ft.
3.30E	17.3	173 Ft.	138 Ft.
3.40E	16.8	168 Ft.	134 Ft.
ω3.50E	16.3	163 Ft.	130 Ft.
3.60E	15.9	159 Ft.	127 Ft.
3.70E	15.5	155 Ft.	124 Ft.
ω3.75E	15.3	153 Ft.	122 Ft.
3.80E	15.1	151 Ft.	121 Ft.
3.90E	14.7	147 Ft.	118 Ft.
ω4.00E	14.3	143 Ft.	114 Ft.
4.25E	13.5	135 Ft.	108 Ft.
4.50E	12.7	127 Ft.	102 Ft.

Figure 33-4 Minimum Hook Touchdown Point and Lens Pitch Command

APPLICABLE SHIP	HOOK-TO-RAMP (FT) / HOOK-TOUCHDOWN POINT (FT) FOR BASIC ANGLE OF:				PENDANT LOCATIONS DISTANCE FROM RAMP (FT)			
	3.O	3.5	3.75	4.0	PENDANT 1	PENDANT 2	PENDANT 3	PENDANT 4
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9
CV 64	12.3/234	14.3/234	15.3/234	16.4/234	173.8	213.7	255.2	297.2
CVN 68	12.1/230	14.1/230	15.1/230	16.1/230	169.9	209.9	250.4	291.2

Figure 33-5 Aircraft Recovery Bulletin 62-12, Table 2 (Excerpt)

33.5 CLASS SYSTEM, HOOK TOUCHDOWN POINT, AND STATIC MISTRIM

The hook touchdown point and hook-to-ramp values we just examined in ARB 62-12 are predicated on a level deck where basic angle and lens pitch command are equal. What happens when the deck is not level; i.e., it is statically mistrimmed stern up or down? Prior to CLASS, both hook touchdown point and hook-to-ramp would change with a mistrim condition, and the LSO would have to manually roll the Fresnel lens to reestablish the desired hook touchdown point. Now with the CLASS system, however, a computer automatically adjusts roll angle to compensate for the mistrim condition to maintain a constant commanded hook touchdown point. The one important consideration for the LSO is that since lens pitch command has changed with the mistrim condition, so too has the hook touchdown constant and therefore hook-to-ramp clearance. The LSO must ensure at least 10 feet of hook-to-ramp for normal pendant engagements, in order to land aircraft safely and legally. If insufficient hook-to-ramp results, three options exist:

1) Move the hook touchdown point forward in the landing area to obtain a minimum of 10 feet hook-to-ramp.

2) Increase the basic angle to 3.75 or 4.00 degrees.

3) Rig the MOVLAS.

EXAMPLE #1: USS NIMITZ (CVN-68)

3.5 degree basic angle
230 feet HTDP
1.25 degree stern up pitch mistrim due to significant damage forward.

First determine the new lens pitch command. Static pitch mistrim is directly added to/subtracted from the basic angle to determine lens pitch command:

3.5 deg basic angle
- <u>1.25 deg stern up mistrim</u>
2.25 deg lens pitch command

Hook touchdown constant for 2.25 degrees = 25.5 (1/TAN 2.25E) (HTDC is derived from lens pitch command, not basic angle).

Since CLASS keeps the hook touchdown point constant:

230 feet/25.5 = 9.1 feet H/R.

This yields insufficient hook-to-ramp clearance (10 feet required), therefore we have to exercise one of the three above options.

For Option 1:

10 feet H/R X 25.45 HTDC = 254.5 feet HTDP. Tell the Air Boss to target a HTDP of 255 feet.

For Option 2:

Tell the Air Boss to go to a 3.75 degree basic angle. Now the lens pitch command is 2.5 degrees (3.75 - 1.25 = 2.5). The hook touchdown constant for 3.25 degrees is 22.9.

230 feet HTDP / 22.9 HTDC = 10.04 feet H/R.

Now the aircraft will land between the #2 and #3 wires as desired, with the minimum 10 feet of hook-to-ramp clearance.

One factor to keep in mind when elevating the basic angle is that a higher wind over deck may be required at the higher glideslope angles. Consult ARB 29-12/13 series bulletins to determine any changes to wind requirements.

EXAMPLE #2: USS EISENHOWER (CVN-69)
3.5 degree basic angle
230 feet HTDP
0.5 degree stern down pitch mistrim

Lens pitch command:
3.5 deg basic angle
+0.5 deg stern down mistrim
4.0 deg lens pitch command

Hook-to-ramp = HTDP/HTDC
= 230 feet/14.3
= 16.1 feet H/R

In this situation, your hook-to-ramp is fine; you are ready to land aircraft. Ideal hook-to-ramp has changed from 14.1 feet (ARB 62-12) to 16.1 feet due to the pitch mistrim.

33.6 RETARGETING WIRES

The retargeting of wires on today's aircraft carriers is a greatly simplified task with the CLASS system. Since hook touchdown point is one of the inputs to CLASS, it only takes the push of a button to change the HTDP to any desired location in the landing area. In selecting a commanded hook touchdown point, the LSO must remember to maintain a corresponding minimum of 10 feet of hook-to-ramp clearance.

EXAMPLE #1: USS CONSTELLATION (CV-64)
Level deck
3.5 degree basic angle
#3 and #4 wires missing

In this situation, the #2 wire must be targeted. From ARB 62-12, Table 2 we can find the location of the #1 and #2 wires at 173.8 and 213.7 feet respectively. The mid point between these wires is approximately 195 feet.

193" HTDP/16.3 HTDC = 11.8 H/R

This is sufficient H/R but, if for any reason, the basic angle could be raised to 3.75 or 4.0 degrees to increase H/R clearance. Lastly, iff raising the glideslope is not possible or not desirable, then rigging the MOVLAS is always an option.

EXAMPLE #2: USS NIMITZ (CVN-68)
3.5 degree basic angle
0.5 degree stern up pitch mistrim
#3 and #4 wires missing

In this example, we have a retargeting problem combined with a static mistrim problem. First, figure out the lens pitch command and corresponding HTDC:

3.5 degree basic angle
- 0.5 degree stern up mistrim
3.0 degree lens pitch command

Hook touchdown constant for 3.0 degrees = 19.1.

Next, determine the pendant locations from ARB 62-12, Table 2. The table shows the #1 and #2 pendants are located at 169.9 and 209.9 feet respectively. Targeting the mid-point between these wires yields a desired HTDP of 190 feet.

Opting to stay with a 3.5 degree basic angle, we can target back to 191 feet while maintaining the required minimum of 10 feet hook-to-ramp:

19.1 HTDC (mistrim) X 10 feet (minimum H/R) = 191 feet HTDP.

This is within one foot of our desired HTDP, so tell the Air Boss to spot 191 feet on a 3.5 degree basic angle. You are now ready to recover aircraft. If unable or undesirable to operate with this minimum H/R, increase BA or rig MOVLAS.

33.7 EFFECT OF STATIC ROLL MISTRIM ON LENS PITCH COMMAND

The overall effect of ship's static roll mistrim on lens pitch command is usually very small and almost negligible when compared to the effect of static pitch mistrim,as discussed above. The change in hook-to-ramp distance is approximately six to eight inches for one full degree of roll mistrim on most ships; in contrast, a pitch mistrim of only 0.5 degrees may affect hook-to-ramp clearance by as much as two feet. The change in lens pitch command and hook-to-ramp become relatively significant only for very large roll mistrim situations, approximately 2 degrees or more. The effects of roll mistrim on glideslope geometry are far overshadowed by the problems in lineup control caused by the tendency of pilots to level their wings with the listing deck.

The calculation of the effect of roll mistrim on lens pitch command is a very involved process. This in-depth calculation, which considers the fact that the roll axis of the ship is located below deck, is detailed below for information purposes only. Appendix A contains all pertinent deck layout data for these solutions and is used in defining the variables in the formulas which follow.

CALCULATING THE CHANGE IN LENS PITCH COMMAND TO ROLL MISTRIM

Variable definitions:

ΔLPC - The change in lens pitch command (degrees).

C_L SHIP - Centerline of ship (roll axis)

C_L LA - Centerline of landing area

Θ - Angle between centerline of landing area and roll axis (degrees).

m - Mistrim angle (degrees).

F - Distance from ramp to center of pitch along roll axis (feet).

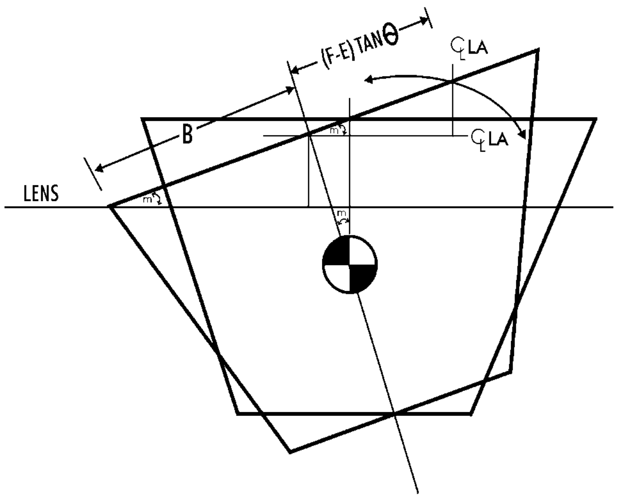
E - Distance from center of pitch to intersection of centerline of landing area and the roll axis (feet).

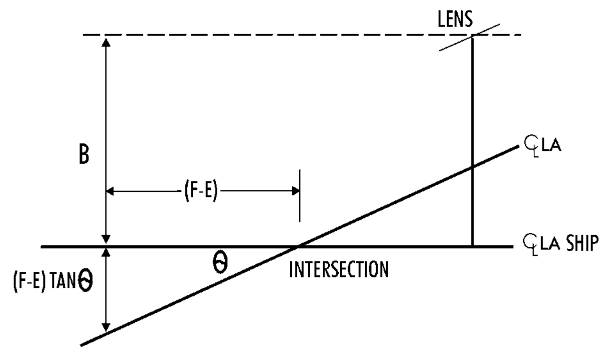
B - The perpendicular distance from roll axis to lens position (feet).

C - The perpendicular distance from centerline of landing area to lens position (feet).

A - The distance from the ramp to the lens position along the centerline of the landing area (feet).

COMPUTING THE SLOPE OF THE LANDING AREA CENTERLINE IN RELATION TO THE LENS POSITION IN A MISTRIM SITUATION.

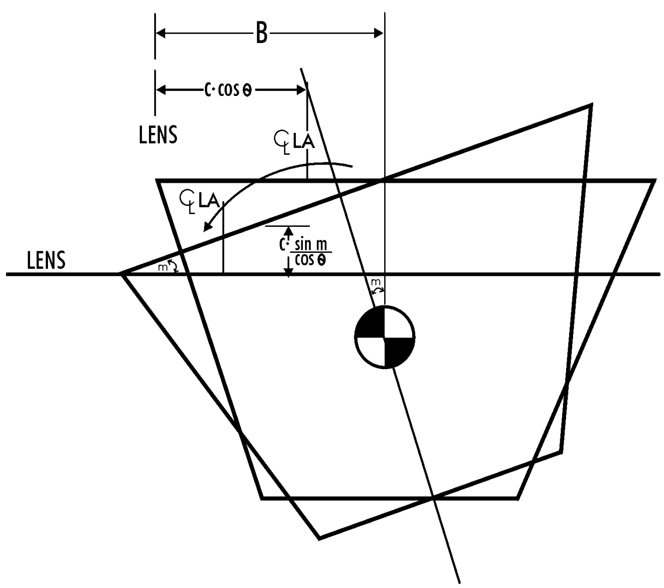


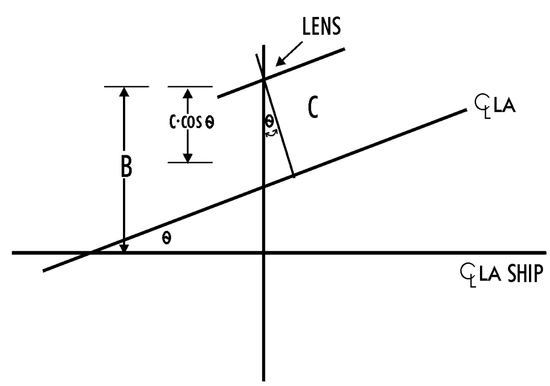


First divide the ship into cross sections at the ramp and at the lens.

Cross Section @ Ramp **Looking Straight Down**

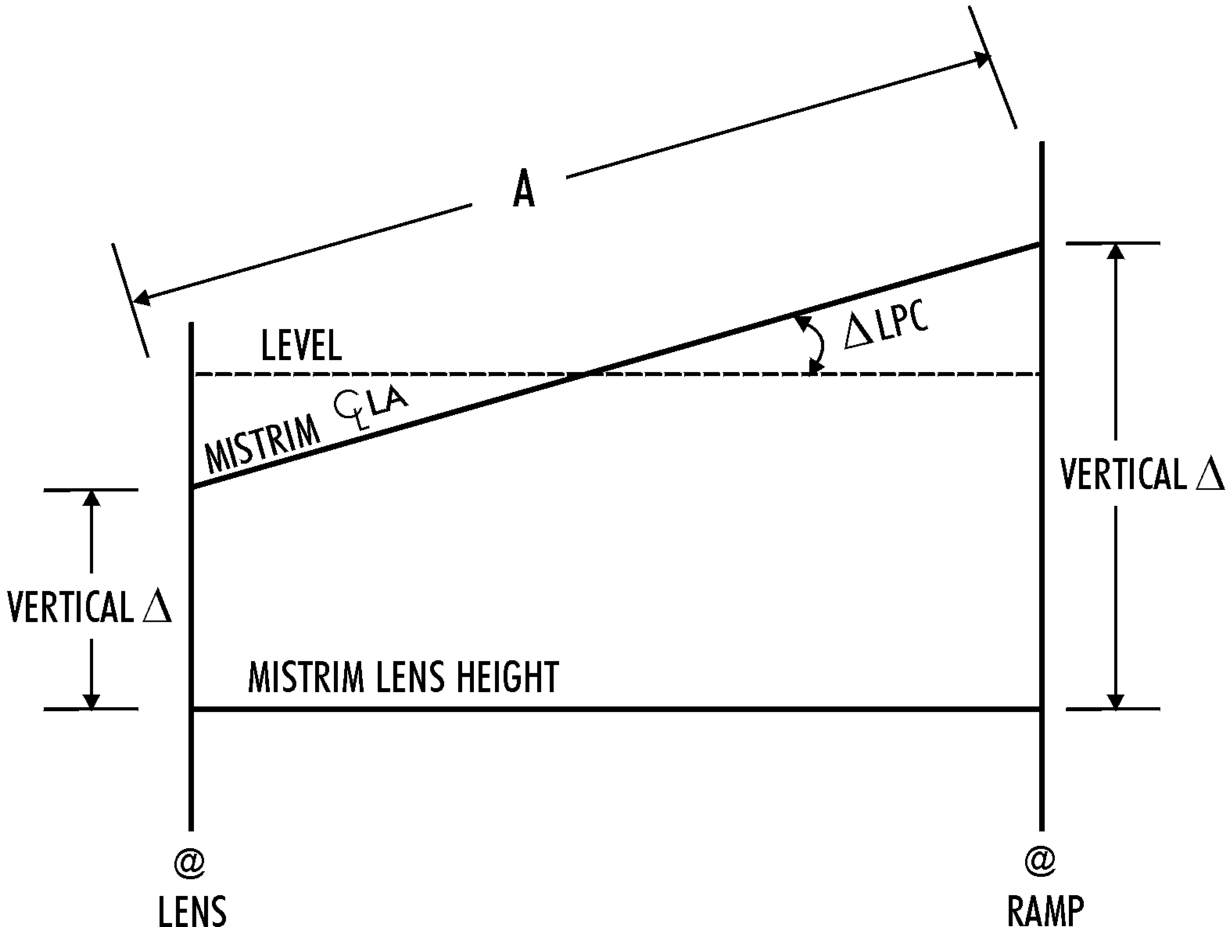
Vertical distance the LA centerline is above the lens (Vertical Δ @ Ramp) = (B+(F-E)*tan Θ)*sin m





Cross Section @ Ramp **Looking Straight Down**

Vertical distance the LA centerline is above the lens = (Vertical Δ @ Lens) = C*sin m/cos Θ



Slope of LA Centerline in Relation to Lens Command

The slope of the centerline = $\dfrac{\text{(vertical } \Delta \text{ @ ramp) - (vertical } \spadesuit \text{ @ lens)}}{\text{distance from ramp to lens along centerline}}$

The change in Lens Pitch Command due to roll = Slope in relation to lens =

$$\boxed{\Delta LPC = \sin^{-1} \left(\frac{\sin(m)*(B+(F-E)*\tan(\Theta)-C/\cos(\Theta))}{A}\right)}$$

Example: For CVN-71

A = 486.1' E = 287.3'
B = 134.3' F = 460.9'
C = 85.0' $\Theta = 9.05^{O}$

For 1^{O} of port mistrim ($m = +1^{O}$)

$$\boxed{\Delta LPC = \sin^{-1} \frac{((\sin(1^{O})*(134.3+(460.9-287.3)*\tan(9.05^{O})-85/\cos(9.05^{O})))}{(486.1)}}$$

LPC = $\sin^{-1}$ (.00272)

LPC = <u>.1561</u>^{O}
New Lens Pitch Command for a 3.5^{O} Basic Angle = 3.34^{O}

33.8 SHIP'S DYNAMIC MOTION AND GLIDESLOPE GEOMETRY

The CLASS system maintains a constant commanded hook touchdown point while compensating for ship's static mistrim. Ship's dynamic motion, however, yields an instantaneous, dynamic hook touchdown point which may be quite different from that being commanded by CLASS. The dynamic or instantaneous hook touchdown point may be determined in a similar manner as if you were calculating a changing HTDP as a result of changing hook-to-ramp clearance, assuming a constant glideslope relative to the horizon (perfect stabilization).

Figures 33.6 and 33.7 depict typical dynamic HTDP changes as a result of dynamic heave and pitch motion. Note that +/-5.5 feet of motion may yield dynamic HTDP changes of +/-80 feet or more; 1.5 degrees of pitch motion may change dynamic HTDP by as much as 190 feet, depending on the class of ship. Although dynamic hook-to-ramp; i.e., the instantaneous H/R which results from deck motion, may transit below 10 feet as the deck cycles, the LSO's primary concern is commanded H/R. As long as the CLASS system is commanding at least 10 feet H/R, then the LSO may continue to recover aircraft using the FLOLS. If deck motion becomes excessive, MOVLAS is always an option. LSOs must have an appreciation of these dynamic factors when controlling aircraft in pitching deck scenarios.

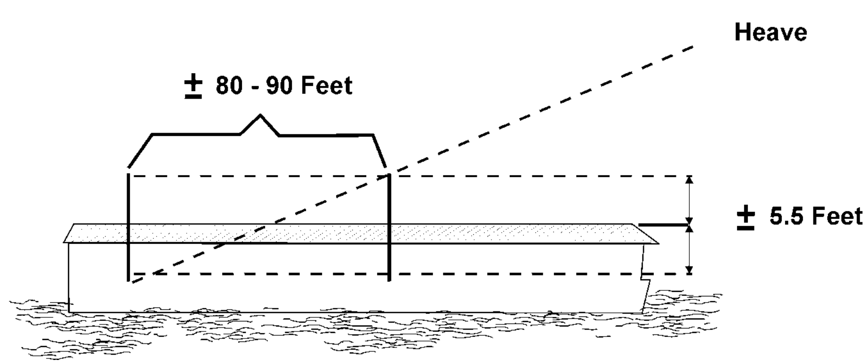
33.9 GLIDESLOPE GEOMETRY AND BARRICADE RECOVERIES

In order to carry out a successful barricade arrestment, an LSO must have a solid working understanding of the barricade system, the situational factors which require specific actions and decisions, and various considerations in actually controlling the approaching aircraft.

Once the decision to use the barricade has been made, an LSO must first determine the exact configuration, actual approach speed, and gross weight of the aircraft. Then, ARB 26-12 or 29-12 should be consulted to obtain the maximum engaging speed and weight limits for the barricade arresting engine. From this information, the LSO can easily calculate the wind over deck requirement to ensure a safe barricade recovery. The LSO must then decide whether the FLOLS or MOVLAS will be utilized for the recovery, based upon a number of factors including deck motion and hook-to-ramp clearance.

If the FLOLS is to be used, ARB 62-12 must be consulted to determine the proper lens settings - optimum hook touchdown point, hook-to-eye, and hook-to-ramp clearance. A 4.0 degree basic angle will be set, with a minimum hook-to-ramp clearance of eight feet being required.

EFFECTS OF HEAVE MOTION



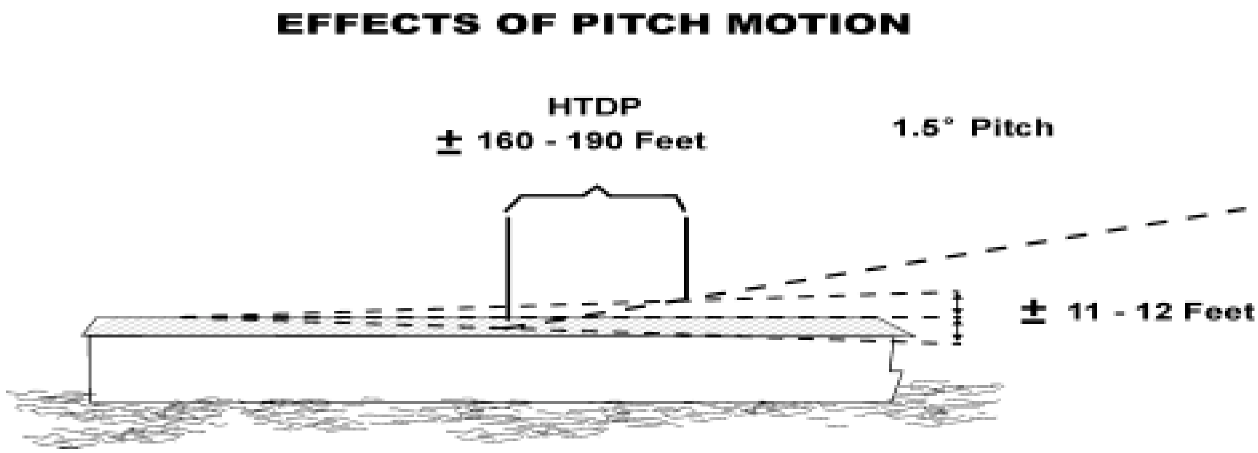


Figure 31-6 Effects of Heave Motion

Figure 31-7 Effects of Pitch Motion

ARB 62-12 also delineates the pilot's eye height at the barricade position, and whether the aircraft will have three points on deck rolling into the barricade (annotated by an asterisk next to the eye-height value). If no asterisk is given, the aircraft is in a very critical situation by not having three points on deck at the barricade position (the nosewheel may be off the deck) - an important factor for the LSO to consider.

If the prescribed minimum hook-to-ramp clearance cannot be obtained with the optimum HTDP set in CLASS, due to a severe stern up pitch mistrim situation with a high hook-to-eye aircraft (e.g., F-14 or EA-6B), then the FLOLS should not be used. This is especially critical for those aircraft which will not have three points on deck going into the barricade - there is no tolerance to move the optimum HTDP forward to obtain the minimum H/R clearance. The MOVLAS should be rigged. Lastly, ARB 12-12 should be consulted, if necessary, to determine the crossdeck pendant configuration for the barricade. In many landing gear malfunction scenarios, this ARB dictates removal of all pendants to facilitate optimum aircraft attitude entering the barricade.

Once preparations for the barricade rigging are made, the LSO must brief the pilot on the following ten items, in accordance with LSO NATOPS:

1. Deck motion
2. Wind over deck conditions
3. Criticality of lineup control and drift
4. Airspeed control and max engaging speed limits
5. Importance of glideslope control to touchdown
6. Loss of the ball in close due to barricade stanchion
7. LSO voice calls to be expected
8. The cut" call and action required
9. Inability to execute a late own waveoff
10. Use of 4.0 degree glideslope, or MOVLAS if applicable.

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APPENDIX A

Carrier Identification and Deck Plans

Aircraft carriers are grouped nominally by class. All ships built to the same basic plans are of the same class. This class, normally, takes the name of the first ship of the class to identify the entire class, i.e., Nimitz Class. Extensive modifications of a carrier must usually be accomplished during an availability period for the ship. Because of rigid operational commitments, such availability periods are staggered to minimize the number of ships which are not operational during a given period of time. The total time required to modify a class of ships may extend over a period of two or three years and the requirements for intended modification may be decreased, expanded, or revised during this time. Consequently, non-uniformity of configuration and equipment exists among the carriers of a given class, and the grouping of the vessels together by class is a matter of convenience rather than a complete definition of their aircraft support capabilities.

Figures A-1 through A-4 show the plans for KITTY HAWK, CONSTELLATION, ENTERPRISE and KENNEDY. Figure A-5 illustrates the deck plans for a NIMITZ class CVN.

Figures A-6 and A-7 show carrier dimensions in reference to the Deck Edge Assembly location. These dimensions are required for glideslope geometry computations.

Figure A-8 shows the ILARTS centerline camera locations on each CV. This is useful in ILARTS analysis.

Figure A-9 shows carrier dimensions, displacement and types of launching and recovery equipment installed.

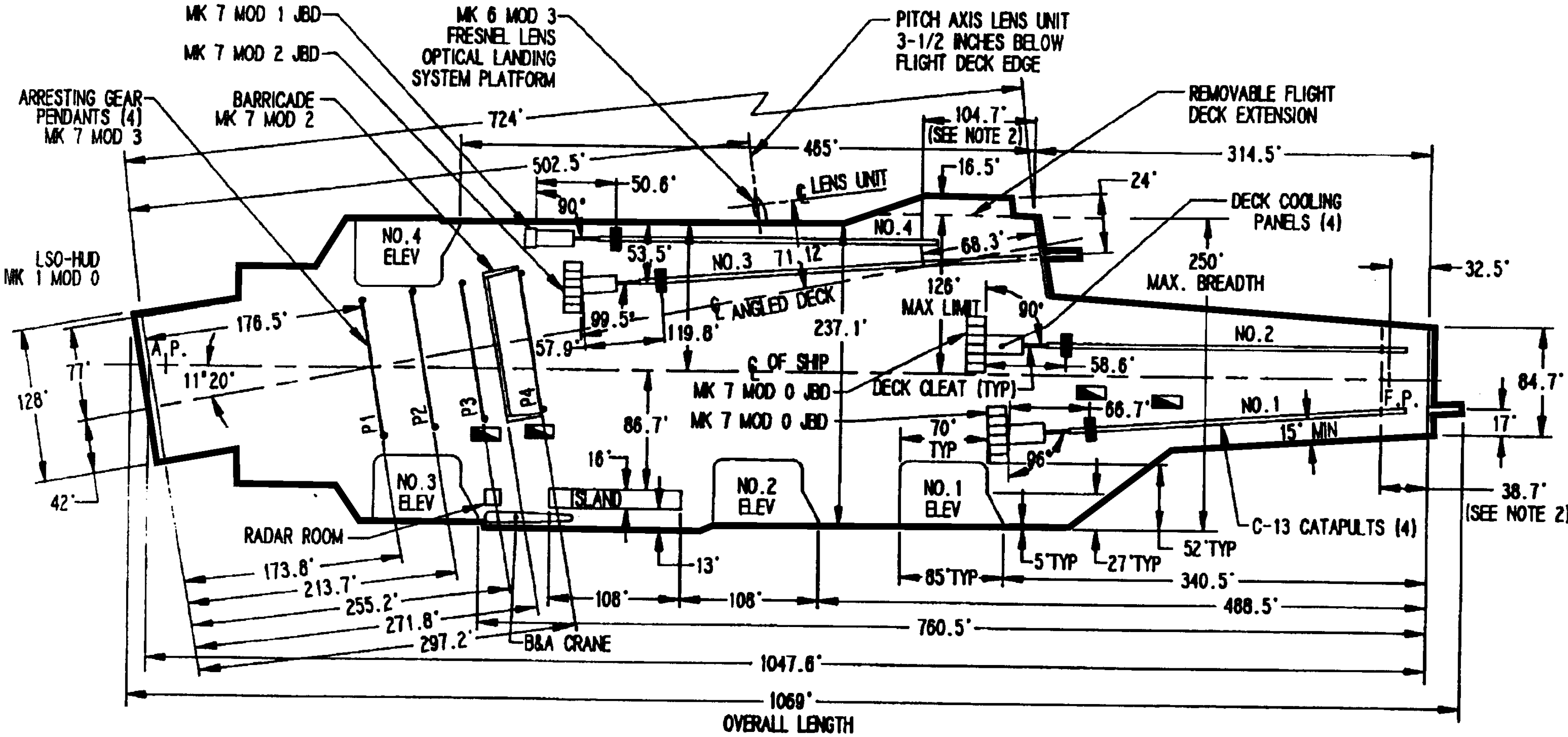


Figure A-1 CV-63 KITTY HAWK – Plan and View of Flight Deck

NOTES:
1. Dimension locating barricade is shown to £ of its raised position.
2. Flat deck forward of end of power stroke.
3. Arresting gear deck sheaves marked thus and all barricade stanchions lie flush with the deck when not in use.
4. Dimensions shown are approximate with accuracy sufficient for planning purposes

Legend:

Bomb and missile elevator
Dimension is from catapult station "0" to JDB hinge line

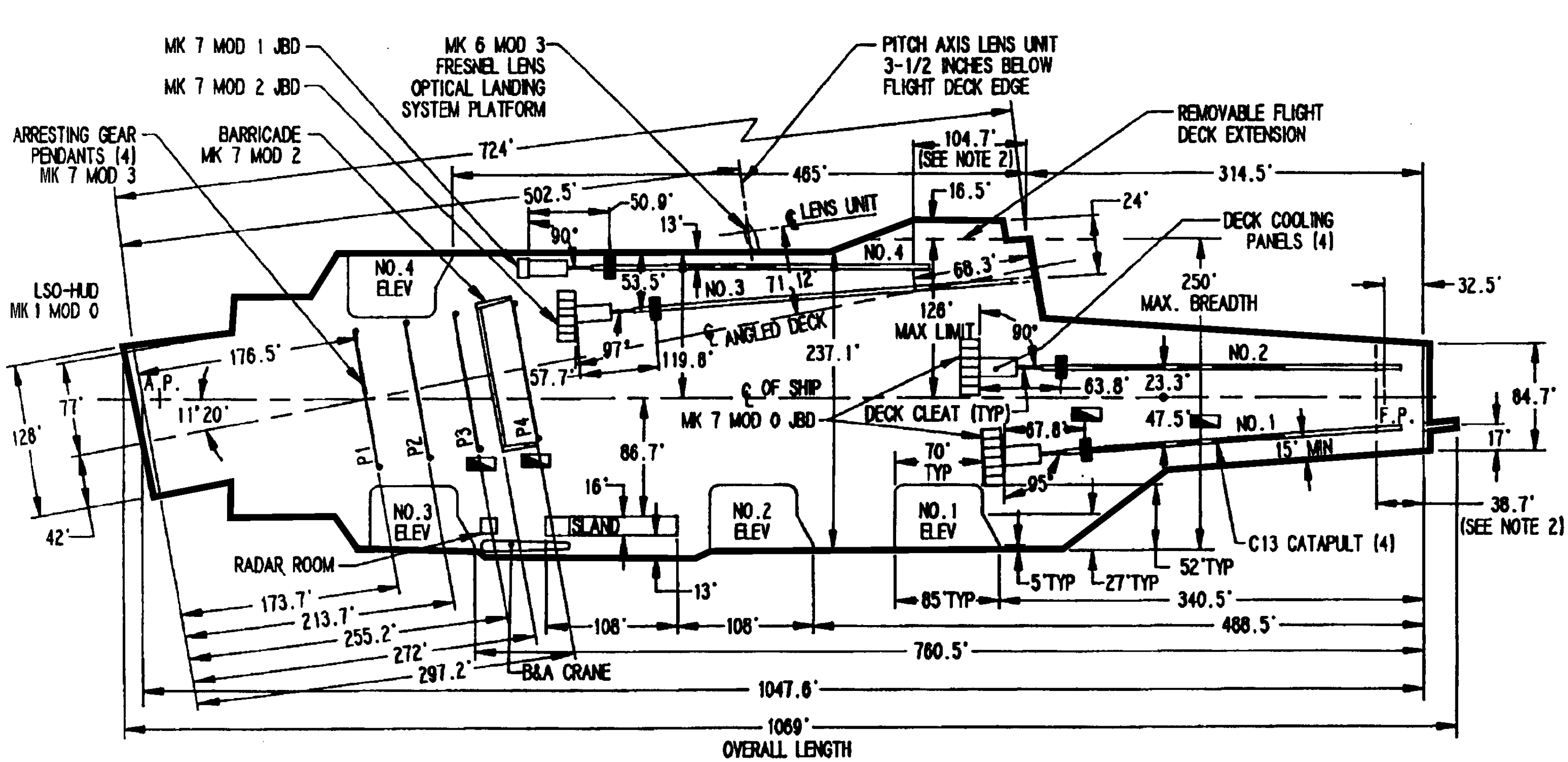


Figure A-2 CV 64 CONSTELLATION –Plan and View of Flight Deck

NOTES:

1. Dimension locating barricade is shown to £ of its raised position.
2. Flat deck forward of end of power stroke.
3. Arresting gear deck sheaves marked thus and all barricade stanchions lie flush with the deck when not in use.
4. Dimensions shown are approximate with accuracy sufficient for planning purposes

Legend:

Bomb and missile elevator

Dimension is from catapult station "0" to JDB hinge line

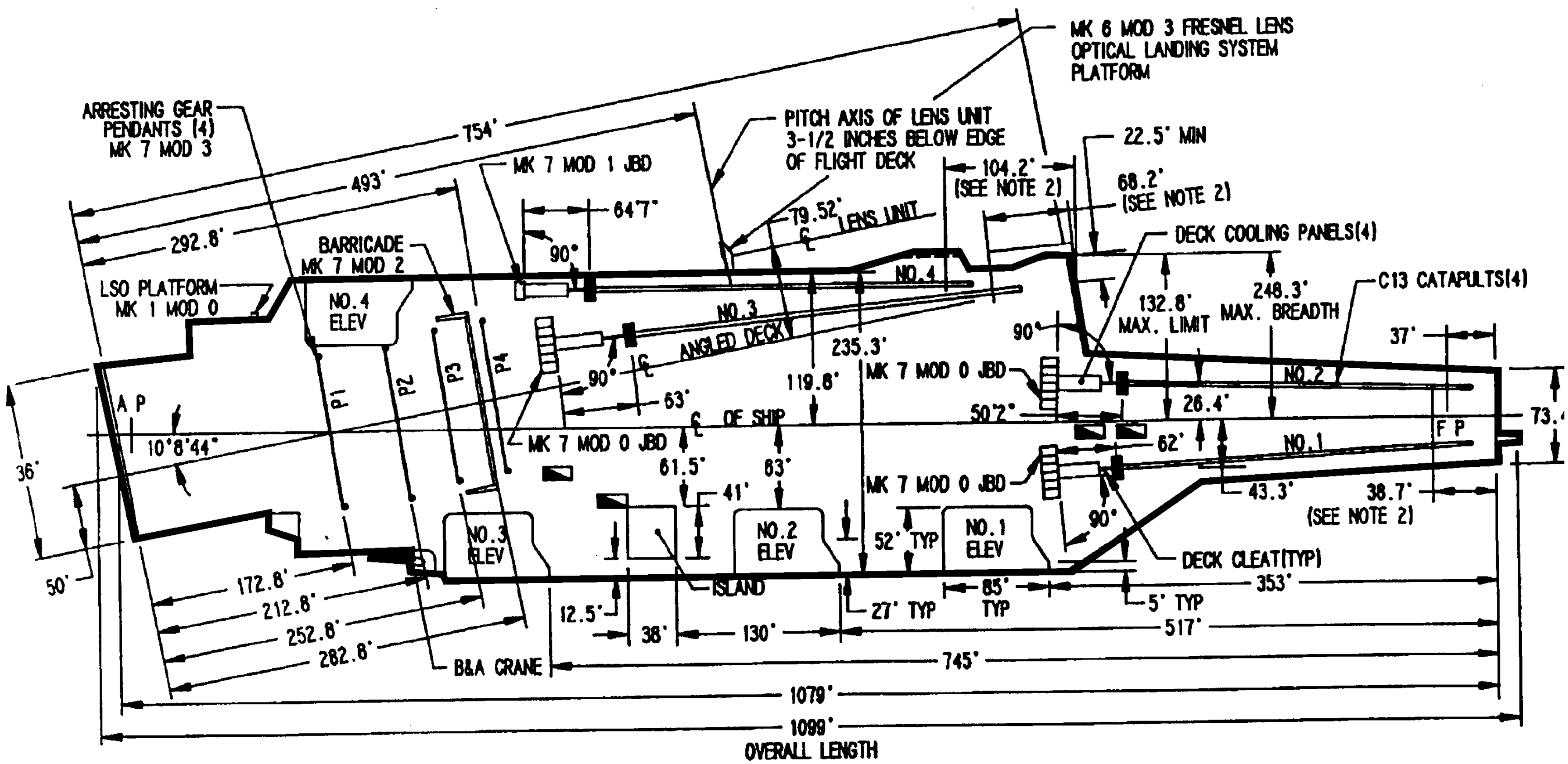


Figure A-3 CVN 65 ENTERPRISE – Plan and View of Flight Deck

NOTES:
1. Dimension locating barricade is shown to £ of its raised position.
2. Flat deck forward of end of power stroke.
3. Arresting gear deck sheaves marked thus and all barricade stanchions lie flush with the deck when not in use.
4. Dimensions shown are approximate with accuracy sufficient for planning purposes

Legend:

Bomb and missile elevator

Dimension is from catapult station "0" to JDB hinge line

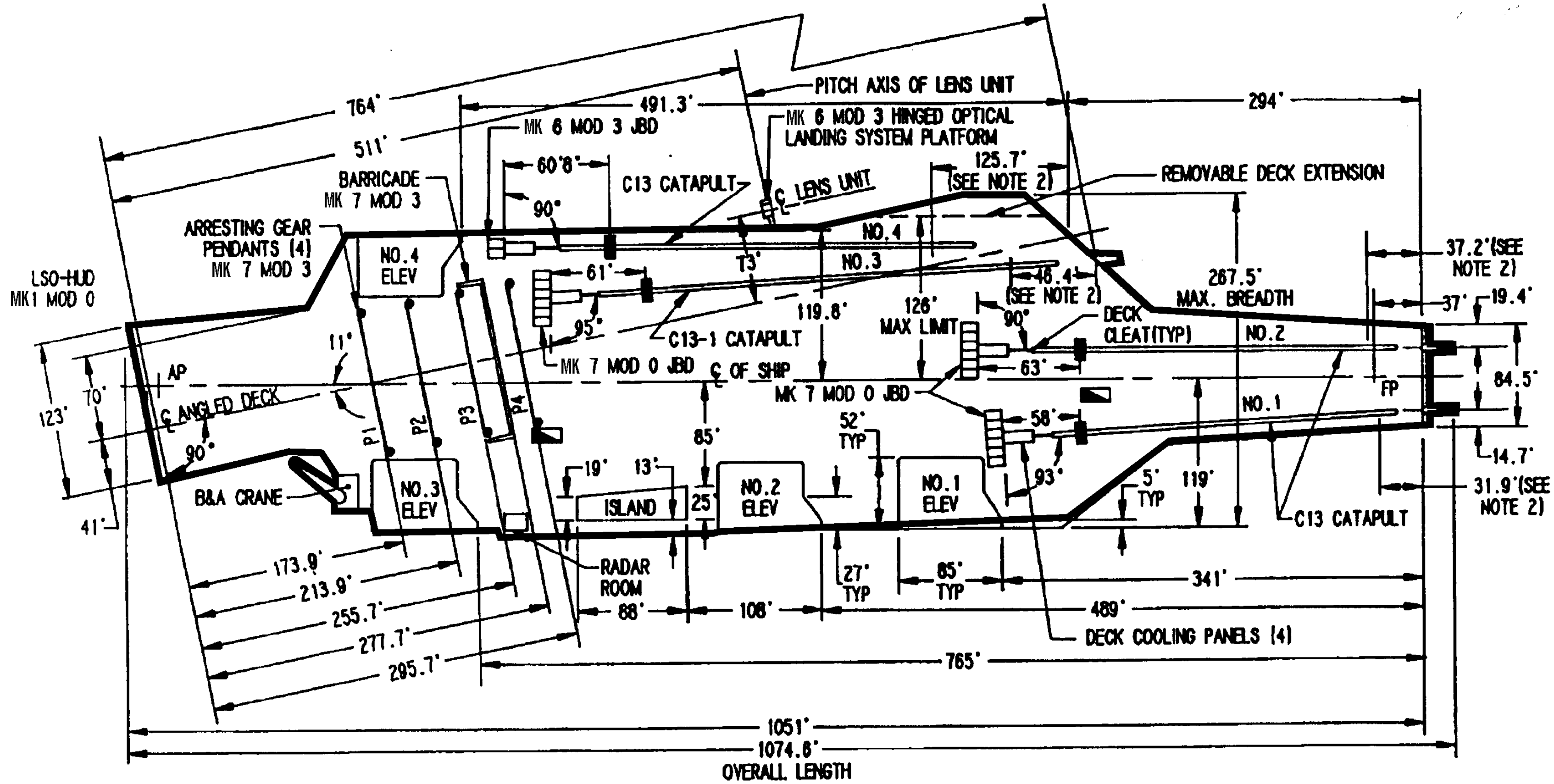


Figure A-4 CV 67 JOHN F. KENNEDY – Plan and View of Flight Deck

NOTES:
1. Dimension locating barricade is shown to £ of its raised position.
2. Flat deck forward of end of power stroke.
3. Arresting gear deck sheaves marked thus and all barricade stanchions lie flush with the deck when not in use.
4. Dimensions shown are approximate with accuracy sufficient for planning purposes

Legend:

Bomb and missile elevator
Dimension is from catapult station "0" to JDB hinge line

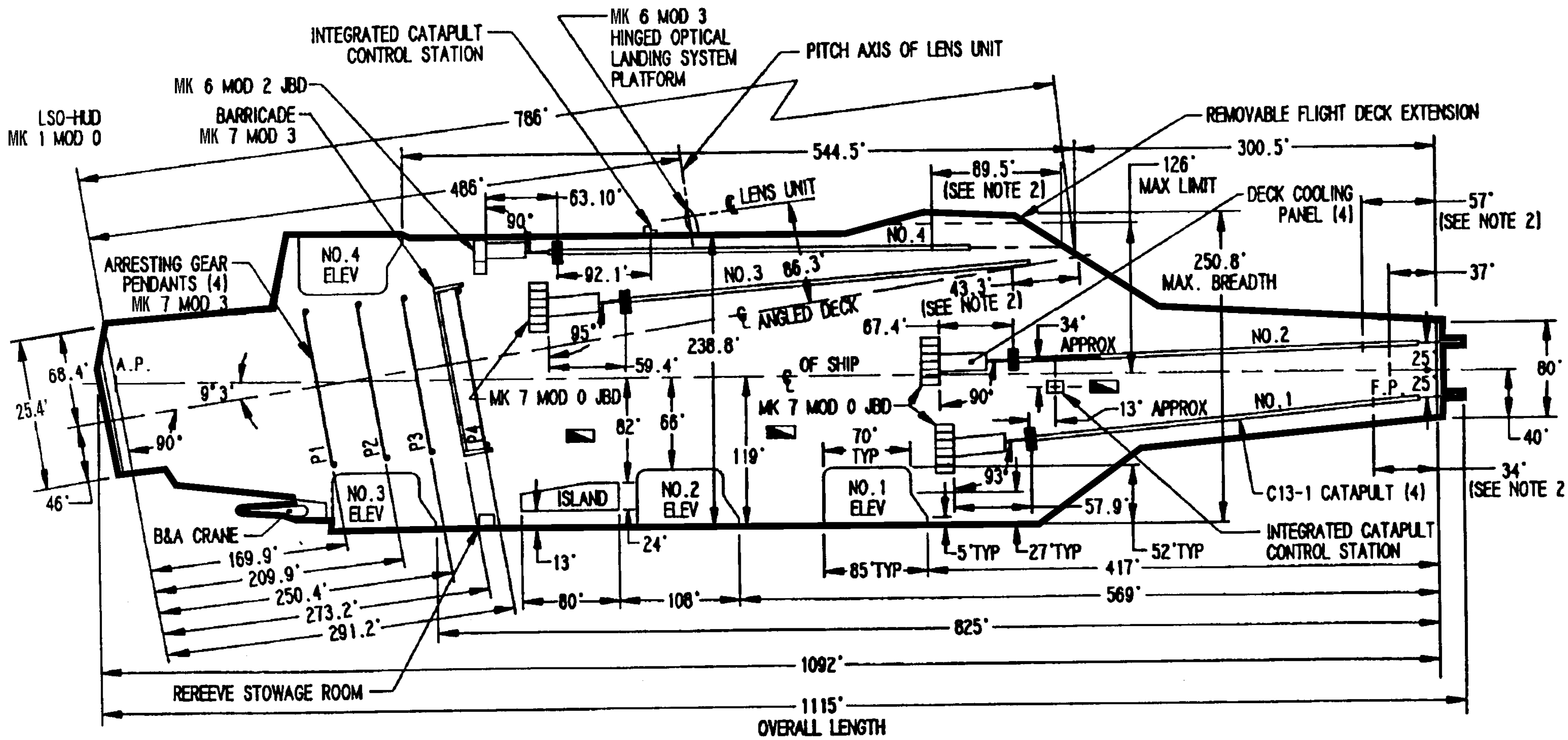


Figure A-5 CVN 68 NIMITZ Class – Plan and View of Flight Deck

CVN 68 NIMITZ
CVN 69 EISENHOWER
CVN 70 VINSON
CVN 71 ROOSEVELT
CVN 72 LINCOLN
CVN 73 WASHINGTON
CVN 74 STENNIS
CVN 75 TRUMAN
CVN 76 REAGAN

NOTES:
1. Dimension locating barricade is shown to £ of its raised position.
2. Flat deck forward of end of power stroke.
3. Arresting gear deck sheaves marked thus and all barricade stanchions lie flush with the deck when not in use.
4. Dimensions shown are approximate with accuracy sufficient for planning purposes

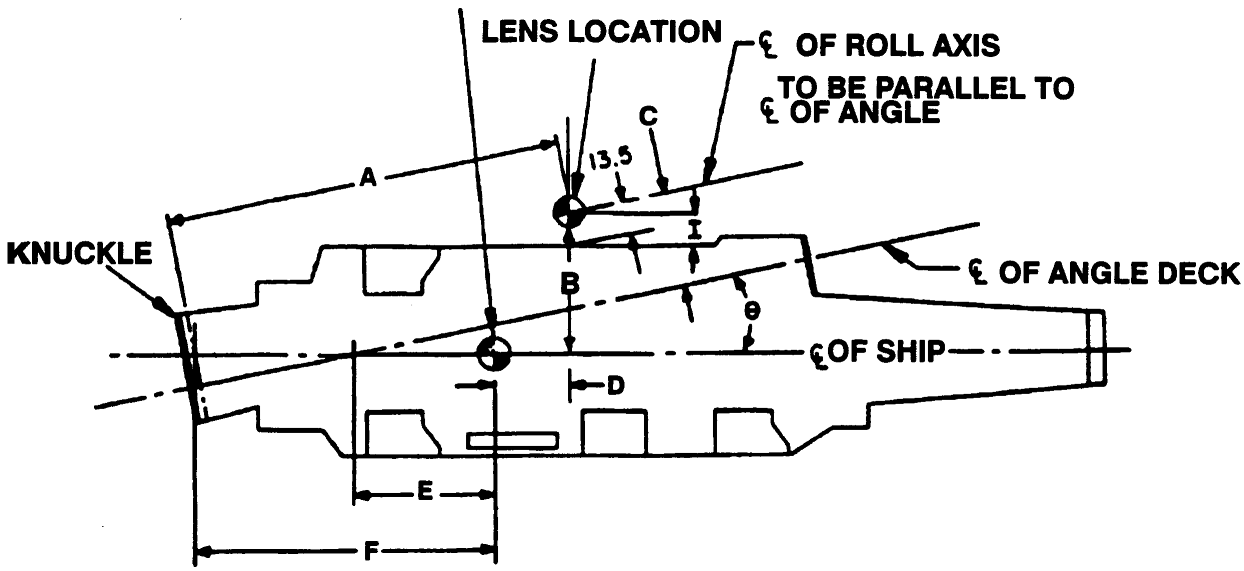
Legend:

Bomb and missile elevator
Dimension is from catapult station "0" to JDB hinge line

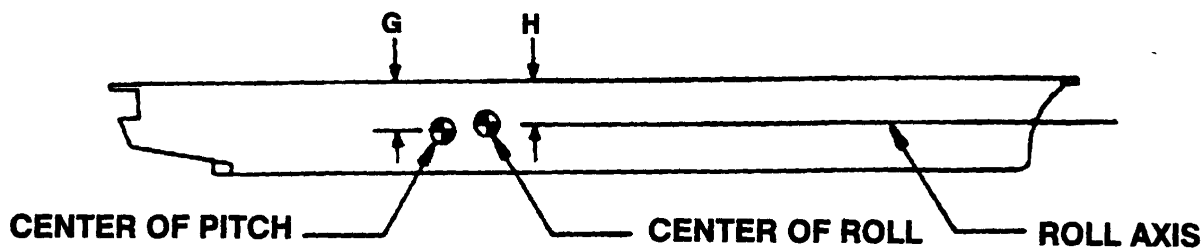
	A	B	C	D*	E	F**	0	G	H	I
CV-63	501' 8"	133' 11"	71' 5"	52'	252' 6"	433'	11^{O} 20' 21"	66'	51'	14' 2"
CV-64	500' 5"	133' 7"	71' 5"	51' 11"	252' 6"	433'	11^{O} 18'	66'	51'	13' 2"
CVN-65	491' 3"	133' 7"	80' 2"	20' 4"	278'	455'	11^{O} 7'	64'	51'	13 2"
CV-67	500' 3"	133' 1"	72' 8"	55' 1"	260' 8"	437' 10"	11^{O}	51' 2"	51' 2"	13' 3"
CVN-68	485' 10"	135' 3"	86' 3"	10' 6"	286' 6"	460' 1"	9^{O} 3'	54' 5"	54' 5"	14' 4"
CVN-69	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-70***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-71***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-72***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-73***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-74***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-75***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'
CVN-76***	486' 1"	134' 4"	85'	10'	287' 4"	460' 11"	9^{O} 3'	53' 7"	53' 7"	15'

* Distance forward of pitch axis
** Pitch moment arm
*** Data based on data for CVN-69

Figure A-6 Deck Edge Assembly Location Chart



TOP VIEW OF DECK



INBOARD PROFILE

Figure A-7 Deck Edge Assembly Location Illustration

NAME	AFT CAMERA DISTANCE FORWARD OF RAMP	FWD CAMERA DISTANCE FORWARD OF RAMP
CV-63 KITTY HAWK	362	400
CV-64 CONSTELLATION	442	508
CVN-65 ENTERPRISE	477	521
CV-67 KENNEDY	467	516
CVN-68 NIMITZ	480	535
CVN-69 EISENHOWER	476	527
CVN-70 VINSON	475*	505*
CVN-71 ROOSEVELT	475*	505*
CVN-72 LINCOLN	475*	505*
CVN-73 WASHINGTON	475*	505*
CVN-74 STENNIS	475*	505*
CVN-75 TRUMAN	475*	505*
CVN-76 REAGAN	475*	505*

*Calculated distance aft of ramp

Figure A-8 Integrated Launch and Recovery Television Surveillance System (ILARTS) Camera Locations

NAME	FULL LOAD DISPLACEMENT (TONS)	FLIGHT DECK DIMENSIONS (a)	CATAPULTS MODEL / NO.	RECOVERY EQUIPMENT (b) (c)		FLOLS
				MODEL / NO. OF ENGINES	NO. OF DECK PENDANTS	
CV-63 KITTY HAWK	75,200	1025 X 237 / 724	C13 / 4 (e)	MK 7 MOD 3 / 4 MK 7 MOD 2 / 1	4	MK6 MOD 3
CV-64 CONSTELLATION	75,200	1025 X 237 / 724	C13 / 4 (e)	MK 7 MOD 3 / 4 MK 7 MOD 2 /1	4	MK6 MOD 3
CVN-65 ENTERPRISE	85,000	1079 X 251 / 754	C13 / 4 (e)	MK 7 MOD 3 / 4 MK 7 MOD 2 / 1	4	MK6 MOD 3
CV-67 KENNEDY	78,000	1029 X 239 / 764	C13 / 3, C13-1 / 1 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-68 NIMITZ	90,579 (d)	1077 X 252 / 786	C13-1 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-69 EISENHOWER	90,579 (d)	1077 X 252 / 786	C13-1 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-70 VINSON	90,579 (d)	1077 X 252 / 786	C13-1 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-71 ROOSEVELT	90,579 (d)	1077 X 252 / 786	C13-1 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-72 LINCOLN	90,579 (d)	1077 X 252 / 786	C13-2 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-73 WASHINGTON	90,579 (d)	1077 X 252 / 786	C13-2 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-74 STENNIS	90,579 (d)	1077 X 252 / 786	C13-2 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-75 TRUMAN	90,579 (d)	1077 X 252 / 786	C13-2 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3
CVN-76 REAGAN	90,579 (d)	1077 X 252 / 786	C13-2 / 4 (f)	MK 7 MOD 3 / 5	4	MK6 MOD 3

(a) Length X width / length angle deck in feet
(b) Pendants and barricades incorporate sheave dampers
(c) All ships have one 24' hydraulic barricade installation
(d) Combat load displacement is 93,026 tons
(e) These catapults are of dry accumulator type
(f) These catapults are of wet accumulator type

Figure A-9 Carrier Dimensional, Launching and Recovery Data

APPENDIX B

REFERENCES

1. Aircraft Launching Bulletins

2. Aircraft Recovery Bulletin No. 62-12 (Mk 6 Mod 3 FLOLS)

3. Aircraft Recovery Bulletin No. 10-10

4. Other Aircraft Recovery Bulletins
   (1) ARB 0-11
   (2) ARB 12-12
   (3) ARB 29-12/13

5. CNAL/CNAPINST 3100.4 Air Department SOP

6. CNALINST 13800.3 Aircraft Launch and Recovery Operations Manual

7. CNAPINST 13800.9 Aircraft Launch and Recovery Operations Manual

8. CV NATOPS Manual, NAVAIR 00-80T-105

9. Flight Deck Awareness Pamphlet (Naval Safety Center)

10. Landing Signal Officer Manual (LSO NATOPS), NAVAIR 00-80T-104

11. NAVAIR 51-40ACA-3 (Mk 2 Mod 2 Landbased MOVLAS)

12. NAVAIR 51-40ACA-2 (Mk 1 Mod 2 Shipboard MOVLAS)

13. OPNAV Form 3760/71, Pilot Performance Record

14. OPNAVINST 3750.6 Naval Aviation Safety Program

15. OPNAV 3710.7 General NATOPS Manual

16. Ship Board Organization Manual

17. Technical Manual, Fresnel Lens Optical Landing System Mk 6 Mod 3, Installation, Service, Operation and Maintenance Instruction (NAVAIR 51-40ABA-10)

18. Visual Landing Aids General Service Bulletin No.8 (Latest Revision)

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APPENDIX C

LIST OF ACRONYMS AND ABBREVIATIONS

A

ACLS Automatic Carrier Landing System

ADMAT Administration and Material Inspection Guide

AFGT Advanced Formal Ground Training

AQDs Additional Qualification Designator

APARTS Automatic Performance Assessment and Readiness Training System

APC Approach Power Compensator

ARB Aircraft Recovery Bulletin

C

CAFSU Carrier and Field Service Unit

CARQUAL Carrier Qualifications

CATCC Carrier Air Traffic Control Center

CCA Carrier Controlled Approach

CDP Cross Deck Pendant

CLASS Carrier Landing Aid Stabilization System

COMNAVAIRLANT/CNAL/AIRLANT Commander, Naval Air Force, U.S. Atlantic Fleet

COMNAVAIRPAC/CNAP/AIRPAC Commander, Naval Air Force, U.S. Pacific Fleet

CNATRA Commander Naval Air Training

CV(N) Aircraft Carrier (Nuclear)

E

ECSS Electronic Crosshairs Stabilization System

EMCON Emission Control

F

FCLP Field Carrier Landing Practice

FGT Formal Ground Training

FLOLS Fresnel Lens Optical Landing System

FPM Feet Per Minute

FRS Fleet Readiness Squadron

G

GCA Ground Control Approach

H

H/E Hook-to-Eye

HUD Heads-Up-Display

I

ICLS Instrument Carrier Landing System

IFF Identification, Friend or Foe

IFGT Initial Formal Ground Training

IFLOLS Improved Fresnel Lens Optical Landing Aid System

IFR Instrument Flight Rules

ILARTS (PLAT) Integrated Launch and Recovery Television Surveillance System

IMC Image Motion Compensation

L

LLLTS Low Light Level Television System

LRLS LASER Range Line-up System (LRLS)

LSO Landing Signal Officer

M

MOVLAS Manually Operated Visual Landing Aid System

N

NATOPS Naval Air Training and Operating Procedures Standardization

NFOs Naval Flight Officers

NORDO No-Radio

O

OCDR Officer Data Control Report

OLS Optical Landing System

OTC Officer in Tactical Command

P

Pri-Fly Primary Flight Control Station

R

RHW Recovery Headwind

S

SAR Search and Rescue

SATS Short Airfield Tactical Support

SLEP Service Life Extension Plan

SOP Squadron/Standard Operating Procedures

T

TRACOM Training Command

TRAWING Training Wing

V

V/STOL Vertical/Short Takeoff and Landing

VFR Visual Flight Rules

W

WOD Wind Over the Deck